SYSTEMS SOFTWARE PRODUCTS MARKET

WESTERN EUROPE 1990 - 1995

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INPUT OFFICES

North America

San Francisco
1280 Villa Street
Mountain View, CA 94041-1194
Tel. (415) 961-3300
Fax (415) 961-3966

New York
Atrium at Glenpointe
400 Frank W. Burr Boulevard
Teaneck, NJ 07666
Tel. (201) 801-0050
Fax (201) 801-0441

Washington, D.C.
1953 Gallows Road, Suite 560
Vienna, VA 22182
Tel. (703) 847-6870
Fax (703) 847-6872

International

London
Piccadilly House
33/37 Regent Street
London SW1Y 4NF, England
Tel. (071) 493-9335   Fax (071) 629-0179

Paris
52, boulevard de Sébastopol
75003 Paris, France
Tel. (33-1) 42 77 42 77   Fax (33-1) 42 77 85 82

Frankfurt
Sudetenstrasse 9
D-6306 Langgöns-Niederkleen, Germany
Tel. (0) 6447-7229   Fax (0) 6447-7327

Tokyo
Saida Building
4-6, Kanda Sakuma-cho
Chiyoda-ku, Tokyo 101, Japan
Tel. (03) 3864-0531   Fax (03) 3864-4114

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SYSTEMS SOFTWARE PRODUCTS MARKET WESTERN EUROPE

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Researched by
INPUT
Piccadilly House
33/37 Regent Street,
London SW1Y 4NF
England

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Mountain View, CA 94041-1194
U.S.A.

Market Analysis Programme—Europe

*Systems Software Products Market
Western Europe, 1990-1995*

Abstract

This report analyses the system software products market in Western Europe and its growth potential over the period 1990 to 1995.

System software products are defined by INPUT as comprising system control software, operations management tools and application development tools.

The report provides market size estimates for 1990 and forecasts to 1995 for the systems software products market in three subsectors—mainframe, minicomputer and workstation/PC. These forecasts are provided for Western Europe as a whole and for each European country market with the exception of Greece, Portugal and Ireland, which are treated as a group.

Leading vendors are identified and key environmental factors discussed.

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I

Introduction

I

Introduction

A
Objectives

This report has been produced as part of INPUT's Western European Market Analysis Programme for the computer software and services industry. The objective of the report is to provide a market assessment for the systems software sector in Western Europe. This assessment includes:

- An analysis of the overall size of the market and its subsectors.

- A forecast for market growth for the period 1990-1995.

- An analysis of the leading vendors active in this market sector.

- A commentary on major forces shaping the systems software market and the resulting implications for vendors.

B
Scope

The report covers all countries within Western Europe—with the exception of Greece, Portugal and the Republic of Ireland, which are treated as a group for analysis purposes.

The systems software products market is analysed in this report into the three subsectors of mainframe, minicomputer systems and workstation/PC, as is shown in Exhibit I-1. This Exhibit describes INPUT's overall classification of the computer software and services industry.

A more detailed definition of the systems and applications software products segments is provided in Appendix A. Systems software products are broadly defined as comprising three different types of software product:

- Systems control.
- Operations management software.
- Application development tools.

EXHIBIT I-1

Information Services Industry Structure—1990

Information Services Industry

Business Application Solutions

- Processing Services
  - Transaction
  - Utility
  - Other
- Turnkey Systems
  - Equipment
  - Software
  - Prof. Svcs.
- Applications Software
  - Mainframe
  - Minicomputer
  - Workstation/PC

Information Services Industry

- Systems Software
  - Mainframe
  - Minicomputer
  - Workstation/PC
- Network Services
  - Electronic Information Services
    - Data Bases
    - News
  - Network Applications
    - VANs
    - EDI
    - Electronic Mail
- Professional Services
  - Consulting
  - Education& Training
  - Software Development

Systems Management Services

- Systems Operations
  - Processing Services
  - Prof. Svcs.
- Systems Integration
  - Equipment
  - Software
  - Prof. Svcs.
  - Other

Source: INPUT

Systems control software products provide life to the hardware. This category includes operating system software and operating enhancements such as general system utilities, disk/tape/file utilities, print facilities/ spoolers and peripheral drivers.

Operations management tools and utilities include operating system performance monitoring, job scheduling, user control, resource chargeback systems, security/auditing systems, tape and disk I/O optimisers, and network management and communications monitoring programs.

Application development tools include software products such as relational database management systems (RDBMSs) and related fourth-generation languages (4GLs), support tools, computer-aided software engineering (CASE) solutions, knowledge-based development environments, and object-oriented programming and database systems, as well as traditional third-generation software products and general utility packages.

C
Methodology

The research that contributed to this study derived from the following sources:

- INPUT's on-going Western European software and services market research, which includes the collection of revenue and product information from over 300 vendors annually.

- Interviews with senior managers from independent software products vendors and equipment vendors.

- The use of INPUT's extensive library facilities, which include vendor literature and press releases as well as trade press, newspaper and magazine articles and previous INPUT reports relevant to the system software products market sector.

D
Report Structure

The remaining chapters of this report are organised as follows:

- Chapter II contains an executive overview of the key points within the report.

- Chapter III describes the overall market for systems software products, including its size and forecast growth in Western Europe. It also describes the principal market sectors and identifies the leading vendors in this market.

- Chapter IV provides detailed market data for each individual country market.

- Chapter V describes important trends in software product technology relevant to the systems software sector.

- The appendixes comprise a definition of terms, the exchange rates and inflation assumptions used, detailed forecast data in local currencies and in ECUs, and a reconciliation of the overall forecast for Western Europe with that published by INPUT in 1989.

II

Executive Overview

II
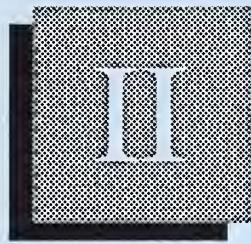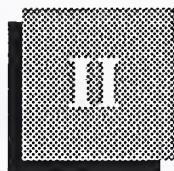
Executive Overview

A

Downsizing Lowers System Software Product Market Growth

After a decade of high growth, the systems software products sector is now slowing as a result of the decline of the computer equipment market (largely caused by downsizing) and the selection of lower cost mini-computers and workstation platforms to replace larger equipment configurations. An expected increase in the practice of software product bundling by equipment vendors as a response to increasingly competitive market conditions will depress future growth in this market, which is predicted to achieve only a 15% compound average growth rate over the next five years. Nevertheless this growth will generate a systems software products market worth $21 billion in 1995.

The systems software products sector (the general operating and application development environment for the computer hardware) and the applications software products sector have achieved remarkable growth over the last ten years. From under one billion U.S. dollars in sales in 1979, the industry achieved over $18 billion by 1989 and averaged a growth rate in excess of 30% per annum throughout the decade. As is shown in Exhibit II-1, a much lower growth expectation is now forecast over the next five years.

INPUT forecasts a divergence of the growth rate characteristics for applications products and for the system software products market over the next five years. This divergence is particularly apparent when it is taken into account that each of these forecast growth rates includes an inflation estimate of in excess of 5% per annum. The applications product market is expected to achieve almost double the real growth rate of the systems software sector. These trends reflect increasing user emphasis on an applications packaged solution on downsized system platforms and an increasing vendor emphasis on bundling of system software products on those platforms.

Applications software product growth is driven, amongst other factors, by substitution for in-house or custom-developed applications and is thus not limited by the overall slowing in growth of the computer industry or of the economy as a whole. In contrast the systems software product sector is limited to a significant extent by these factors.

Another potential inhibiting factor in the systems software product market is the reality of multiple de-facto standards. Products are introduced faster than standards bodies can function, resulting in a certain amount of user confusion. This confusion in turn leads to delayed product acceptance by vendors and users. However, open system standards, notably UNIX, are having a profound impact in the market and achieving significant growth, albeit at the expense of other system software product sectors.

The market will also ultimately benefit from new generations of more-complex system software products—for example, for relational database management systems and co-operative processing across networks.

EXHIBIT II-1

Systems Software Product
Market Growth Declines

Product Sector	Western Europe Average Annual Growth (Percent)	
	1979-1989	1989-1995
Systems Software	33	15
Applications Software	35	23

B

Key Software Product Categories

The software products sector can be considered as comprising four distinct categories, each one categorised by its function in relation to the equipment platform on the one hand and the user's application on the other. This categorisation is shown in Exhibit II-2.

At the top of the diagram in Exhibit II-2 is the applications software product sector. This sector, the subject of a companion report, *Applications Software Products—Western Europe, 1990-1995,* consists of general business software, generic applications (such as graphics, spreadsheets and word processing products) and applications-specific products. Applications-specific products can be categorised as industry-specific or

cross-industry packages. The line between system and application software products is usually drawn at the level of database management systems (DBMS) products. For all platforms except the PC, a DBMS is considered a system software product.

The system software products sector, the subject of this report, is made up of the other three categories shown in Exhibit II-2—applications development tools, operations management tools and systems control products. Applications development tools are shown adjacent to the applications sector to which they relate and separately from the remaining two sectors, which are concerned with the control and operational management of the equipment platform.

Applications products and applications development tools are the province of users and personnel with applications development responsibility. Operations management tools and systems control products are concerned solely with the provision of the system resources upon which the applications run.

Application development tools are used to prepare applications by assisting in the process of their design, programming, testing and related functions. This category thus includes traditional programming languages, 4GLs, data dictionaries, database management systems, CASE tools, and other development productivity aids. Also included are graphical user interfaces and system utilities that are directly invoked by an applications program.

Operations management tools provide assistance to manage computer and network systems and operating personnel more efficiently. The category includes mainframe job scheduling and accounting systems, disk/tape systems, and performance monitoring and tuning systems.

In contrast to the operations management functions, system control products are primarily supervisory programs that deliver the computer and network resources to the application through automatic management and allocation. These products include operating systems, emulators, network control products like NetView and NetMaster, library control, access control and spoolers.

EXHIBIT II-2

Software Product Categories

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┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
│          Applications         │
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
┌───────────────────────────────┐
│    Applications Development    │
└───────────────────────────────┘

┌───────────────────────────────┐
│    Operations Management       │
├───────────────────────────────┤
│       Systems Control          │
└───────────────────────────────┘
```

C

System Software Product Market Forecast

The market forecast for the total Western European systems software products market is shown in Exhibit II-3. In terms of equipment platform subsectors, the highest market growth is expected to be manifested in the workstation/PC subsector, the lowest in the mainframe subsector, a forecast consistent with the continuing trend of downsizing.

The workstation/PC portion of the system software products market was only 16% in 1989 but is projected to increase to a 27% share by 1995. However, the mainframe sector will still be the largest individual sector of the market in 1995. This growth pattern fundamentally reflects user downsizing of their equipment needs to gain the cost/performance benefits of smaller systems. It also reflects increasing use of networking and the co-operative processing solutions that make downsizing a practical step in many applications. In the future, mainframes will be increasingly reserved for computer-intensive scientific, batch and high-throughput transaction processing (database access) applications, as well as for wide-area network-based intelligent network switching.

Two other factors that will affect the future growth of the system software products sector are:

• Software product bundling.

• Multiple de facto standards.

The practise of software product bundling effectively lowers the size of the open market measured by end-user expenditures. Bundling restricts to a certain extent the degree of user choice as well as removing revenue directly from the sector. Both IBM and Digital have adopted this tactic with some system software products.

The pace of product introductions, particularly in the new product category of distributed/co-operative processing, has greatly exceeded the rate at which standards-making bodies function. The consequent introduction of de facto standards for networking, graphic user interfaces and other programming interfaces has caused considerable user confusion which delays the acceptance of products.

EXHIBIT II-3

System Software Products
Market Forecast

Subsector	Western European User Expenditures ($ Billions)		
	1990	1990-1995 CAGR (Percent)	1995
Mainframe	5.4	9	8.2
Minicomputer	3.1	17	7.0
Workstation/PC	1.8	26	5.9

D

The Impact of UNIX

The market for UNIX system software products has now emerged as a fast-growing opportunity within the minicomputer and workstation/PC sectors. Exhibit II-4 shows the market growth expectation over the next five years. The principal reason for this rapid growth has been the de-facto adoption of UNIX as the prime open-operating-system standard by equipment vendors. The economics of computer system development and fragmented market shares of most proprietary operating systems have led to a polarisation around three fundamental de-facto standards:

- IBM systems.
- Digital VMS systems.
- UNIX systems.

This polarisation has been most marked in the minicomputer sector, where proprietary operating systems, excluding those from IBM and Digital, account for only one quarter of the total market. To break out of this restriction and achieve market growth, vendors have had to adopt UNIX strategies. This has become an increasingly credible strategy with the acceptance of UNIX within the commercial environment, contributing factors being:

- User acceptance of open systems concepts.
- Increasing availability of UNIX application package products.
- The introduction of more advanced facilities within UNIX operating systems.

UNIX does, however, have its limitations and these lie primarily in the areas of large-scale data processing and high-integrity on-line transaction processing (OLTP). However, STRATUS has developed its own fault-tolerant version of UNIX with the ultimate goal of developing it to eventually equal or exceed the performance of its own proprietary operating system (Virtual Operating System). UNIX is being driven towards use in the OLTP sector by the growth of networking. Standards organisations such as X/Open and OSF have recognised the need for transaction processing support in UNIX and this is likely to give support to its development.

EXHIBIT II-4

The Impact of UNIX

Subsector	Western European User Expenditures ($ Billions)		
	1990	1990-1995 CAGR (Percent)	1995
Minicomputers	0.4	26	1.4
Workstations/PCs	0.1	50	0.8

E

Competitive Environment

The close relationship between system software products and the equipment platforms that they drive polarises the competitive environment into two groups, equipment vendors and independent vendors. The equipment vendors dominate the whole sector with seven out of the leading ten vendors for the market overall. The leading five equipment vendors are listed in Exhibit II-5. The largest independent vendor is Computer Associates (CA), as is shown in Exhibit II-6, which lists the leading independent systems software product vendors.

IBM dominates this market with a share of around one-quarter of the total. This position is related to IBM's predominant position in the mainframe market and the large proportion of the total market accounted for by the mainframe sector.

In the future the market share held by equipment vendors is likely to fall. There appears an increasing trend to bundle system software products back into the equipment platform as a response to competition from independents. This has the effect of reducing the overall available market. For example, were Digital's VAX system software products unbundled fully, then given the same equipment installed base, the company would have generated a further $400 million in revenue during 1989 within the systems software products market.

Another reason for a predicted fall in the equipment vendors' relative market share is the expected growth of the applications development tools sector. This is more likely to favour the independent vendors than the equipment vendors.

EXHIBIT II-5

Leading System Software Product Vendors Western Europe, 1989

Company	Market Share (Percent)	Estimated Revenues ($ Millions)
IBM	25	2,255
Digital	8	700
Siemens	6	560
Bull	4	360
ICL	3	265

EXHIBIT II-6

Leading Independent
Software Product Vendors
Western Europe, 1989

Company	Market Share (Percent)	Estimated Revenues ($ Millions)
CA	2	215
Oracle	2	195
Software AG	2	155
Microsoft	1	85
Cincom	1	65

F

System Control Products

System control products are supervisory programs that provide automatic management and allocation of systems and network resources during the execution of applications programs. This category includes operating systems, emulators, network control products, library control, access control and spoolers. The market consists essentially of software products shipped with equipment platforms and is thus largely dependent upon the unit sales of new computers for its growth. Exhibit II-7 shows the market forecast for systems control products analysed by equipment platform category.

The relative growth rate for each of the equipment platform sectors shown in Exhibit II-7 reflects the impact of downsizing, particularly in the mainframe sector. Nevertheless it is expected to still be the largest individual sector by 1995, albeit that it will have declined from a market share of around 55% in 1990 to about 45% by 1990. This emphasises the strong relationship between the cost of an equipment platform and the price of its associated software.

The most significant recent development in the mainframe sector was the announcement of IBM's Enterprise Systems Architecture (ESA) the new version of MVS, which is expected to be adopted as a standard over the next five years by IBM large-scale users. UNIX is not expected to be a major element in the mainframe system control products market despite Amdahl's objective of establishing it as a major software platform for their mainframes.

In contrast, UNIX will be an important driving force in the minicomputer sector where it is being supported by all the major equipment vendors. The other major driving force in the minicomputer sector will of course be the continuing move towards networking and co-operative computing.

These same factors, UNIX and networking/co-operative computing, will also be important factors in driving growth in the fastest growing sector, that of workstation/PCs. The equipment platforms in this sector will exhibit the greatest growth potential over the next five years. PC DOS is the predominant operating system amongst PCs and this is still likely to be true until well after 1995 despite the development of OS/2-based systems. The OS/2 market is forecast to grow at about 25% per annum, driven by sales in the large corporate sector.

The market for UNIX system software products, as was indicated in Exhibit II-4, is forecast to grow at an average annual rate of 30-40%. This growth is fuelled by the increasing availability of applications products and UNIX equipment platforms.

The general expectation is that the workstation/PC market will divide into three segments:

* Existing PC systems using DOS applications with no need for multitasking. These users will migrate to the use of Microsoft Windows.

* New users for whom OS/2 and UNIX will increasingly represent an attraction as user-friendliness is improved.

EXHIBIT II-7

System Control Products

Subsector	Western European User Expenditures ($ Billions)		
	1990	1990-1995 CAGR (Percent)	1995
Mainframe	2.4	8	3.4
Minicomputer	1.2	15	2.4
Workstation/PC	0.8	20	1.8

- Users with a high degree of dependency on communications with corporate computing requirements for whom OS/2 is still likely to be the preferred development path.

G

Operations Management Tools

Operations management tools are used by operations personnel to manage computer and network resources and thus help to utilise operational personnel more effectively. On mainframes this software product category includes job scheduling and accounting systems, disk/tape library systems, and performance monitoring systems. At the level of workstations and PCs, it includes programs such as disk management utilities.

Operations management tools provide manually directed, macro-level management of resources, whereas systems control products are used by the system for real-time self-management. The market forecast for this product category, analysed by equipment platform size, is shown in Exhibit II-8.

Important growth drivers for this market sector include:

- The increasing complexity of IS data centre management combined with the shortage of skilled personnel.

- The developing opportunity for software products dedicated to manage networks and the intra- and inter-networking of multivendor product systems. Much more sophisticated software products which can monitor remote data centres and networks at one central automated control site will be developed.

- The increasing use of this class of product in the workstation/PC sector as these products are drawn into the intelligent network system of the future.

Vendors in this sector are under increasing pressure to provide more comprehensive services to users. Extensive support and training services are required. They also need to develop more-comprehensive ranges of products as users tend to prefer limiting procurement to a limited range of vendors.

The independent vendors with a strong position in this sector include Candle, Computer Associates, Goal, Legent and Software AG.

EXHIBIT II-8

Operations Management Tools

Subsector	Western European User Expenditures ($ Billions)		
	1990	1990-1995 CAGR (Percent)	1995
Mainframe	1.4	10	2.3
Minicomputer	0.7	18	1.5
Workstation/PC	<0.1	41	0.5

H

Applications Development Tools

Application development tools are used by a system developer to prepare applications for execution by assisting in designing, programming, testing and related functions. This product category includes traditional programming languages, 4GLs, data dictionaries, database management systems, CASE tools and other development productivity aids. Exhibit II-9 shows the market forecast for this subsector analysed by equipment platform size.

EXHIBIT II-9

Application Development Tools

Subsector	Western European User Expenditures ($ Billions)		
	1990	1990-1995 CAGR (Percent)	1995
Mainframe	1.6	11	2.6
Minicomputer	1.3	19	3.1
Workstation/PC	1.0	29	3.6

The applications development tools sector is projected to be the fastest growing segment in the systems software product market. The sector will be driven by the strong need to improve software development in the face of increasing shortages of software engineers. The market is developing in line with the maturing capabilities of application development technologies, notably CASE and its application through more-sophisticated CASE integration strategies.

As the complexity of the software product development requirements increase, further demand for more automated software product support is created. The endorsement of CASE by IBM through its introduction of AD/Cycle will help to legitimise the market through the integration of the required tool sets. However, AD/Cycle will only make its full impact on the market towards the end of the forecast period.

The area of highest growth within this sector is expected to be for workstation/PC platforms. This reflects a trend toward workstation/PC-based applications development with front-end design/prototyping functions and applications code generation performed in the workstation—as for example, in the PACBASE system from CGI. This trend is driven by the development of co-operative processing models.

Co-operative processing models will also favour the growth in the market for minicomputer-based systems as the server element of the distributed computing environment. In contrast the mainframe market for applications development tools, currently the largest, will exhibit the slowest growth profile in response to the predicted shift in emphasis to minicomputers and workstations/PCs.

I

Application Development

Within the applications development tools market the most significant product opportunities are for Data Base Management Systems (DBMSs), fourth-generation languages (4GLs) and CASE tools. The individual growth expectation for these three areas is shown in Exhibit II-10.

Database management systems (DBMSs) are expected to demonstrate lower growth over the next five years than has been achieved historically. Database management systems, once considered simply as data storage, are now a central part of the application. In a maturing market, which to an extent has become saturated, DBMS vendors, such as Oracle, have been forced to become heavily involved in applications development.

Market saturation is primarily a mainframe phenomenon where DB2 has become effectively established as a standard. Greater opportunities exist in the minicomputer market where it is estimated that only 25% of Digital VAX machines have an installed DBMS. The area of distributed

databases may be an important factor in this sector of the market, particularly if relational database architectures are accepted by users. Examples are the development of enterprise-wide computing networks with applications based on relational database management systems running on heterogeneous equipment platforms. Realistically these systems will present complex implementation problems.

Additionally the relational database market is being challenged by the development of object-oriented technology. The major claims being made for object orientation are the ease of maintaining applications and the level of reliability. Some world-class software product vendors, Ingres and Software AG, are now moving into this area previously occupied solely by small start-up organisations.

Object-oriented languages complement the DBMS and are categorised within the language subsector of applications development tools. Smalltalk and C++ are the dominant object-oriented languages classified within the third-generation language group. Ingres has, however, announced what they claim to be the world's first object-oriented fourth-generation language.

The 4GL sector will continue to grow despite the even higher growth expected from the CASE sector. Overall, however, 4GLs have not met the applications development expectations made for them. Some consolidation of the product market is expected.

The CASE sector is expected to demonstrate significant growth over the next five years, as is shown in Exhibit II-10. The U.K. market will probably demonstrate high growth as today the market penetration of CASE tools is relatively low. The same is also true for the Spanish market. France and Germany are expected to grow more slowly, France in particular already being a well-developed market for CASE tools.

One of the principal problems faced by the CASE market has been the lack of standards and the consequent difficulty for users to integrate the various life-cycle products. However, as CASE standards emerge and the various application development technologies are integrated into an I-CASE environment based upon a repository, so will the market develop.

EXHIBIT II-10

Application Development Product Opportunities

Subsector	Western European User Expenditures ($ Billions)		
	1990	1990-1995 CAGR (Percent)	1995
DBMS	2.0	16	4.3
4GL	0.6	20	1.4
CASE	0.2	42	1.4
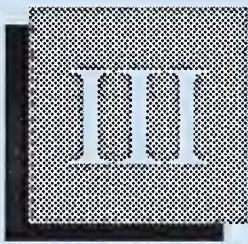
Systems Software Products Market Analysis
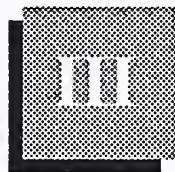
Systems Software Products Market Analysis

A
Market Overview and Structure

Systems software provides the general operating and application development environment for the hardware platform of a computer system. INPUT defines the systems software products market as comprising three types of product, systems control, operations management tools, and application development tools. This structure and the specific functions defined as falling within each category are shown in Exhibit III-1.

The distinctions between systems and applications software products on different equipment platforms are further defined in Exhibit III-2. This illustrates a layered approach to categorising software products. It shows the different layers of standard software required to run and support general-purpose computer systems. Moving down the various categories of software listed on the left-hand side of the table indicates a closer and closer relationship of the software category to the user and the application. In contrast, moving in the opposite direction indicates a closer relationship of the software category to the equipment platform. Equipment platforms are categorised by INPUT into three groups—mainframe, minicomputer and workstation/PC.

Exhibit III-2 illustrates that it is only in the PC platform area that database management systems are classified as applications; for all other product categories they are categorised as systems software. The line between system and application software products is usually drawn between database management system (DBMS) products for all platforms except the PC, where the parameterised DBMS often becomes the application engine itself. The distinction between the following two categories of applications is also shown in Exhibit III-2.

- Business software products; generic applications such as graphics, spreadsheets and word processing, and office automation products.

- Applications software products—industry-specific and cross-industry application packages. Examples of these software products would be respectively an MRPII system for the manufacturing industry and an accounts-payable system.

The overall result of this classification in respect of the PC sector is that expenditures for Lotus are primarily listed in the applications products sector, whereas the expenditures for Microsoft are listed primarily in the systems software products sector.

Systems Software Products
Market Structure, 1990

Systems
Software

Systems Control	Operations Management	Applications Development Tools
• Access control	• Capacity management	• Applications generators
• Communications monitors	• Computer operations scheduling	• Assemblers
• Micro-mainframe links	• Data center management	• Automatic documentation
• Network control	• Disk management	• Configuration management
• Operating systems	• Downtime/repair monitoring management	• Debugging aids
• Security systems	• Job accounting	• Languages (all generations)
• System library control	• Performance monitors	• Systems control
• Other	• Tape management	• Retrieval systems
	• Utilities	• Translators
	• Other	• 4GL
		• CASE
		• Data base management systems
		• Data dictionaries
		• Other

EXHIBIT III-2

Definitional Map of Software Classes

Software Product Category	Equipment Platform		
	Mainframe	Minicomputer	Workstation/PC
Systems Control	S	S	S
Operations Management Tools	S	S	S
Applications Development Tools - Program Development Tools	S	S	S
- DBMS	S	S	S / A
General Business Software	A	A	A
Application-Specific Products	A	A	A

S = System Software Products
A = Applications Software Products

The software products sector (both systems and applications) has shown remarkable growth over the last decade. However, the market for systems software products is expected to grow at a markedly slower rate than that for applications software products. That perspective is illustrated in Exhibit III-3. The principal factors affecting the systems software product sector are:

- A slow-down in the rate of growth of equipment sales. Systems software product revenues, especially the systems control subsegment, are closely related to equipment market growth.

- The expected increase in the practice of software product bundling. Lower equipment prices and commodity product market characteristics, together with increasing competition from independent software product vendors, makes the practice of bundling more attractive and

diminishes the overall size of the direct end-user expenditure on systems software products.

EXHIBIT III-3

Western European Software Products Markets Comparative Growth

Sector	User Expenditures ($ Millions)				
	1979	1979-1989 CAGR (Percent)	1989	1989-1995 CAGR (Percent)	1995
System Software Products	530	33	9,140	15	21,100
Application Software Products	275	35	5,700	23	19,400
Total Software & Services Industry	7,000	22	52,060	18	142,600

The general slow-down in the rate of growth of equipment sales can partly be attributed to the expected recession in the overall economy. However, a far more significant factor is the downsizing phenomenon. Downsizing—users selecting smaller, lower-cost equipment platforms to replace larger systems—is fundamentally driven by the price/performance discontinuity between (at one extreme) mainframes and (at the other) workstations and PCs. This price performance discontinuity, of the order of 200 times, combined with open software standards, leads to totally new system architecture possibilities that are radically altering the market for system software products.

These effects are impacting the mainframe category of system software products where remaining growth can largely be attributed to replacement systems rather than to installations of new systems. Downsizing will benefit the minicomputer and workstation/PC sectors, which will be the principal areas of growth that benefit also from the expected increase in demand for software engineering tools, based on workstations and powerful PCs.

The practice of software product bundling effectively lowers the size of the open market in restricting a user's choice. Both IBM and Digital have adopted this tactic with some system software products. IBM

released the AS/400 midrange system with a DBMS bundled into the proprietary operating system and it also offers a similar package for the PS/2. In 1989 Digital bundled a version of its RDB DBMS into the proprietary VMS operating system of the VAX range. IBM has also been giving certain customer sites free use of DB2 for a nine-month trial period.

Another potential inhibiting factor in the systems software product market is the reality of multiple de-facto standards. The pace of product introductions, particularly in the new-product category of distributed/co-operative processing, has greatly exceeded the rate at which standards-making bodies function. This has led to vendors' introducing a number of networking, graphic user interface, and other programming interface de-facto standards, and has created a great deal of confusion as to which will prevail over the longer term. This confusion has delayed product acceptance by both vendors and end users.

Nevertheless standards, whether de facto or de jure, can also have a positive impact on the market and drive the need for new generations of software that conform to the emerging standards—for example, UNIX software products. Other positive factors for market growth would include:

• Co-operative processing

• Application development/maintenance requirements

An ultimate goal of a truly distributed processing environment is co-operative processing capability, which maximizes the efficiencies of computer networks. To achieve this goal, new generations of more-complex software products, with separate modules executing across the network environment, will be required. The increasing requirement for more-complex applications software solutions, such as the distributed relational model, will fuel demand for relational database management systems software and related application development support tools, and data centre management programs for LAN and inter-LAN-based monitoring and control.

The need to improve software development productivity will drive the market for 4GL/RDBMS and for integrated CASE application development tools, which should accelerate as standards as these product groups emerge. Software maintenance, which possibly consumes 65% or more of the software products application development budget for many organisations, will be a major beneficiary from the implementation of an I-CASE application development program. The integration of all the design and database elements into a common repository is key to the reverse-engineering capability, which addresses the maintenance issue.

In addition, the development of co-operative processing-based applications, such as SAA, will be facilitated by the adoption of I-CASE tools that are specifically designed to support the distributed relational processing model.

B

Market Size and Growth

1. Forecast Assumptions

The market assessments and forecasts provided in this report cover the period 1989 through to 1995 and assess end-user expenditure for systems software products. Market sizes are assessed in local currency and converted into US dollars for aggregation and comparative purposes. The exchange rates used for this purpose are listed in Appendix B. Conversion of the country market forecasts from local currency into ECUs is provided in Appendix D, the ECU conversion rates also being listed in Appendix B.

Forecasts are calculated in actual monetary terms and therefore include allowances for inflation; the inflation assumptions used for each European country forecast are also listed in Appendix B.

2. Market Forecast

The market forecast for the total Western European systems software products market is shown in Exhibit III-4 and is analyzed into the three market segments defined by equipment platform. The market can be further analyzed into the system software product categories defined above in Section A and shown in Exhibit III-3. The market forecast for these three sectors, at the overall European level, is shown in Exhibit III-5. Exhibits III-6 and III-7 provide the more detailed data shown in summary form in Exhibits III-4 and III-5. The market for each of these three product categories is discussed separately in the following subsections of this chapter.

The workstation/PC portion of the systems software products market in 1989 was 16%, and is projected to increase to a 27% share in 1995. This growth reflects the relative cost/performance benefits of networked workstations for a number of business solutions and the expectations for a strong growth in the distributed relational database processing model. It also reflects the continuation of a downward migration in systems software, traditionally run on mainframe platforms, to the 32-bit microprocessor-based workstation/PC platforms while retaining most of the systems software functionality. In a future era of co-operative processing solutions, much of the application processing will be done on workstation/PC platforms, with minicomputers performing the role of network server/ intelligent communications and database management processors, and mainframes performing computer-intensive scientific, batch and high-throughput transaction processing (database access) applications as well as wide-area network-based intelligent network switching.

The highest growth systems software markets are expected to be in applications development and operations management tools. The applications development tool market is benefiting from successive generations of tools that can be integrated into the traditional application development methods with the potential for significantly improving productivity. The operations management tools market receives added stimulus from the need to provide network management tools for the PC LAN environment as well as to extend network management capability on an enterprise-wide scale.

EXHIBIT III-4

Equipment Platform Analysis
Systems Software Products Market

Subsector	Western European User Expenditures ($ Billions)			
	1989	1990	CAGR (Percent)	1995
Mainframe	5.0	5.4	9	8.3
Minicomputer	2.7	3.1	17	7.0
Workstation/PC	1.4	1.8	26	5.9

EXHIBIT III-5

Product Category Analysis
Systems Software Products Market

Product Category	Western European User Expenditures ($ Billions)			
	1989	1990	CAGR (Percent)	1995
Systems Control	3.9	4.3	12	7.6
Operations Management Tools	1.8	2.1	15	4.3
Application Development	3.4	3.9	19	9.3

EXHIBIT III-6

Equipment Platform Analysis Systems Software Products Market Forecast

Subsector	Western European User Expenditures ($ Millions)				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	5,000	5,410	5,890	9	8,250
Minicomputer	2,680	3,120	3,670	17	6,990
Workstation/PC	1,460	1,820	2,300	26	5,860
Total	9,140	10,350	11,860	15	21,100

EXHIBIT III-7

Product Category Analysis Systems Software Products Market Forecast

Product Category	Western European User Expenditures ($ Millions)				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Systems Control	3,915	4,320	4,840	12	7,580
Operations Management Tools	1,825	2,125	2,430	15	4,270
Application Development	3,400	3,900	4,590	19	9,250
Total	9,150	10,350	11,860	16	21,100

The market for UNIX system software products has emerged at the end of the 1980s as a significant opportunity within the minicomputer and workstation/PC sectors. Exhibit III-8 provides INPUT's market assessment and forecast for UNIX system software products over the next five years. A discussion of the impact and potential for UNIX products can be found in Section C-3 below.

EXHIBIT III-8

UNIX System Software Products Market Growth

Product Category	Western European User Expenditures ($ Millions)		
	1990	1990-1995 CAGR (Percent)	1995
Mainframe	11	22	30
Minicomputer	430	26	1,350
Workstation/PC	100	50	750

C

Systems Control Products

1. Market Development

Systems control software products include operating systems and enhancements such as general-system utilities, disk/tape/ file utilities, print utilities/spoolers and peripheral drivers. In effect, systems control software provides life to the hardware. The market consists primarily of software products shipped with hardware and is thus largely dependent upon unit shipments of new computer equipment. Secondarily, the market is driven by new or improved versions of systems control products for installation on existing systems.

Exhibit III-9 shows the market forecast for end-user expenditure on systems control products in Western Europe to 1995; clearly the area of highest anticipated growth is the workstation/PC sector. The factors affecting each of the product platform subsectors are discussed below.

EXHIBIT III-9

Systems Control Products
Market Forecast

Subsector	Western European User Expenditures ($ Millions)				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	2,300	2,420	2,600	8	3,400
Minicomputer	990	1,150	1,320	15	2,350
Workstation/PC	625	750	920	20	1,830
Total	3,915	4,320	4,840	12	7,580

a. Mainframe System Control Products

The mainframe system control market is forecast to grow at only 8% per annum. The downsizing phenomenon has lowered the growth of the mainframe hardware market, which directly impacts the sale of system control products.

The most significant recent development in this sector was the announcement of IBM's Enterprise Systems Architecture (ESA), the new version of MVS. With this development, IBM is aiming to overcome virtual storage constraints and solve the problem of overloaded I/O channels. IBM mainframe customers are expected to adopt ESA as a standard over the next 5 years since conversion for MVS XA is not expected to be particularly difficult. Despite the need for additional resources, users will need to acquire new hardware and software to take full advantage of the system; there are labour-saving benefits. For example, ESA enables the system to automatically manage disk storage without the need for programmers to track storage locations.

UNIX is not expected to be a major element in mainframe system control products market despite Amdahl's determination to establish its own UNIX operating system as a major platform for mainframes. It is estimated that to date only around 200 licences have been contracted worldwide, many of these for UNIX software development rather than for commercial use.

b. Minicomputer System Control Products

The minicomputer platform sector for system control products will experience the second most rapid growth rate, ahead of the mainframe sector but behind that of workstation/PCs. Much of this growth can be attributed to UNIX products that are now being supported by all major equipment vendors, notably Digital, which of course continues to occupy a significant position in this sector. A further discussion of the impact of UNIX software can be found in Section 3, below, on Open Systems Standards.

The overall market size for this sector, shown in Exhibit III-9, understates the real use of minicomputer system control products. This hidden expenditure results from Digital's practice of bundling system control software products into the price of the equipment.

Networking is expected to be a primary growth area in the minicomputer sector.

c. Workstation/PC

The workstation/PC sector is clearly expected to show the strongest growth for system control products over the next few years. Within this sector PC DOS is the predominant operating system, being installed on 90% of currently used workstation platforms. This predominance is forecast to continue until well after 1995. The primary reason for this continuation is that DOS, with the inclusion of Windows, provides the functionality most users require. Users are unlikely to make additional investments in equipment and software when their existing systems provide most current requirements. New workstation/PC users, however, are unconstrained by past investments. As the price of more-powerful personal computers and workstations falls, the trend is to invest in 80386, 80486 and RISC technology.

As a result, more-powerful operating systems—namely OS/2 and UNIX—will be in greater demand. INPUT forecasts that UNIX in the workstation market segment will grow by 40% per annum, this growth fuelled by the increasing availability of UNIX applications products available to the market and the falling price of UNIX equipment. OS/2 products are forecast to grow less rapidly, below 30% per annum, and to be largely restricted to the corporate user market.

PC networking is a major growth area. Whereas in the past, organisations purchased PCs as standalone productivity tools, they are now seeing the benefits of collaborative working and the sharing of common databases. In the late 1980s the number of PC LAN cards sold across Europe increased by between fifty to one hundred percent per year, the growth rates varying by country. Whilst this growth rate will

slow down, networking revenues are forecast to increase in excess of 30 percent per annum through the period 1990 to 1995.

The recurring but unanswered question for workstation/PC application software product providers is: "When will OS/2 gain critical mass in the market?" Users wishing to adopt OS/2 as a standard need firstly to make a substantial investment in memory since it is the availability of memory that determines the number of programs a user can run simultaneously. Applications written specifically for OS/2 run in protected mode, which keeps programs from crashing into one another. However, only about 500 products currently run under OS/2 in protected mode. This number is minimal in comparison to the 20,000-plus applications products currently available for DOS. Whilst there may appear to be a gap in the market and a vast opportunity awaiting applications vendors for OS/2 applications, the reality is vendors prefer to develop products for the largest installed bases. In the case of OS/2, this base is comparatively small, probably less than 2% of the installed base in Western Europe. Writing applications for OS/2 is also more difficult, requiring up to three times the effort needed to write DOS applications.

The arrival of Presentation Manager has improved the marketability of OS/2. However, with the latest announcement of Microsoft Windows 3 for DOS, insufficient differentiation exists to benefit OS/2. Windows 3 offers essentially the same look and feel as Presentation Manager. Users, therefore, will find it difficult to see an immediate benefit in moving to a new operating system that will require equipment upgrades when they can achieve similar objectives by taking up the Windows option. Moreover, applications developers are faced with ever greater challenges in providing applications for OS/2 since they must now not only overcome the complexities of OS/2 itself but the additional ones provided by producing for Presentation Manager.

Nevertheless it is widely expected that by the end of 1990 most of the packages that have been market leaders in DOS cross-industry markets will also be available on OS/2. Windows lacks the power potential of OS/2 since it is designed to run in DOS, and Windows does not offer the multitasking capabilities of Presentation Manager. The implication, therefore, is that existing personal computer users, especially those in small organisations, are unlikely to require or be prepared to make the investment in the multitasking power of OS/2. For these users, often with standalone machines, the requirement for multitasking has diminished as the speed of personal computers has increased. For corporate users, however, the potential for running work on both the server mainframe and standalone PC makes OS/2 an attractive option as the trend to networking develops further.

The expectation, therefore, is that the market will divide into three segments:

- Those with existing PC systems and DOS applications, and no need for multitasking

- New users, be they small companies or newly computerised departments

- Users with a high degree of dependency on communications with corporate computing requirements

In the first case, users are unlikely to need or to wish to use the power offered by OS/2. The upgrade path will be through new releases of DOS and Microsoft Windows. Such a path offers users the ability to work with a Graphical User Interface (GUI) at minimal additional cost and with limited requirements for memory upgrades (typical requirements are 256KB in addition to the 640KB base). Since most DOS-based applications are now available for Windows, Windows itself is gaining rapid acceptance. This segment of the market is by far the largest, in 1990 being in excess of 90% of the total Workstation/PC market.

New users comprise the second segment. For these users, OS/2-, UNIX- and DOS-based applications are all possibilities. UNIX is a strong contender for this group where departmental and specialist solutions may be provided. Windowing and graphical-based operating systems, such as Sunos from Sun Microsystems (available on the Sun SPARCstation), provide user-friendliness which until recently was claimed to be a significant inhibitor to growth of this market.

Other obstacles to the workstation/UNIX solution are being removed with the provision of major-brand general-business packages such as Lotus 123 and Microsoft Word for UNIX. Moreover it is now possible to mix UNIX with Novell networking software. There exist significant growth potential in this area. However, a constraining factor could be the dealer channel, where experience with UNIX is in short supply.

The third segment consists of those corporate users that wish to communicate with mainframe databases and run several jobs concurrently. This area represents a growing opportunity. For these users, OS/2 will be the preferred route. One barrier to migration, the relearning of applications under new systems, will be removed with the convergence of Microsoft Windows and Presentation Manager, which will provide the same look and feel to the user.

2. Operating Systems Polarisation

The de-facto adoption of UNIX as the prime operating system standard for open systems has had a polarising effect on the whole information

systems market. Although the impact of UNIX has been primarily on the minicomputer and workstation sectors, UNIX has been of wider significance in assisting the creation of a trend towards operating systems convergence. The economies of computer system development are causing a convergence of operating systems around three fundamental de-facto standards:

- IBM systems
- Digital VMS systems
- UNIX systems

This polarisation and its impact on vendors dependent upon other proprietary systems is indicated graphically in Exhibit III-10. These effects have been most marked in the midrange of information systems where, IBM and Digital apart, all other proprietary systems are limited to around only one quarter of the total market. To achieve growth they have had essentially to adopt open systems, and in particular UNIX strategies.

EXHIBIT III-10

Tri-Polar Segmentation of the IS Market by Operating Environment

IBM

Fujitsu
Hitachi

Market Pull

Stratus
Tandem

Proprietary
Systems

Nixdorf
Phillips

Amdahl

Bull

ICL

Siemens

HP

NCR

Unisys

Olivetti
AT&T
Sun

Open
Systems
UNIX

Market Pull

Digital
Apple
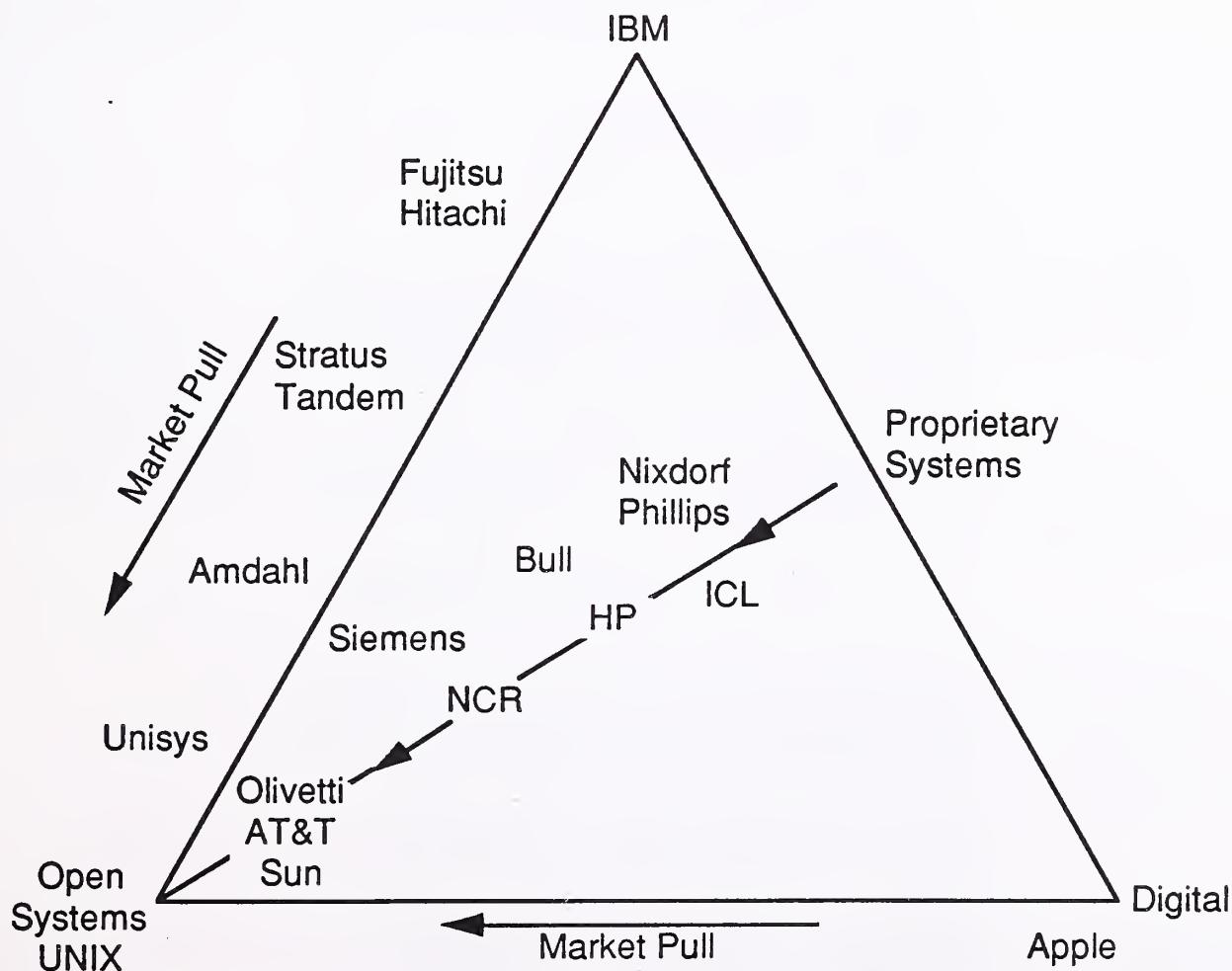
a. IBM

The IBM family of operating systems will retain its position largely as a result of the market share it commands and the investment that users have made. IBM continues to promote SAA as its strategic envelope across its incompatible proprietary systems architectures and this has had the effect of bringing the architectures closer together.

In the mainframe area UNIX is currently not a threat to IBM since it still lacks sufficient power in terms of facilities, such as teleprocessing, that are critical in this environment. In the midrange area IBM's AIX implementation of UNIX is potentially a threat to the AS/400 operating system. The considerable applications investment in AS/400 systems and the fact that AIX is strongly promoted by IBM only for specific technical applications are likely to protect the AS/400 system in the short term.

b. Digital

Digital remains committed to its proprietary VMS environment, which accounts for approximately one quarter of the midrange market in Western Europe. However, Digital has now begun to actively market its ULTRIX UNIX system, which is probably of particular importance to bolster its significant share of the technical workstation sector. Digital is thus able to offer the advantages of its own proprietary architecture and that of UNIX systems.

3. Open System Standards

a. UNIX

Towards the end of the 1980s the trend towards open systems standards, in particular UNIX, gathered considerable momentum. INPUT has estimated that the UNIX software market is growing overall at around 30% per annum. The major element supporting this growth trend has been the acceptance of UNIX as a credible operating system in the commercial environment. Important factors that have contributed to this situation have been:

- User acceptance of open systems concepts.

- Increasing availability of UNIX applications products.

- The introduction of more-advanced facilities under UNIX.

Users have been moving strongly in the direction of open systems as a way of breaking free from dependence upon particular proprietary systems. The demands of European national governments for the adoption of open systems have been particularly important. The open-systems concept is partly driven by the need for ease of network connection,

difficult to achieve amongst separate proprietary systems, and partly by the attraction of application portability. Applications portability is an important concept in markets where commodity equipment platforms are increasingly available.

Growth in the availability of UNIX applications has been a significant factor. The growing attractions of UNIX applications portability to turnkey systems vendors has been an important factor here. The adoption of UNIX has allowed turnkey systems vendors to utilise standard compo-nents—for example, database management systems and communications management software—and to concentrate development funds on the specific application. UNIX has also allowed vendors to gain indepen-dence and strengthen their bargaining positions with equipment suppliers. The equipment vendors have been forced to follow this trend to compen-sate for declining sales of proprietary systems.

The advanced facilities that have increasingly been built into UNIX, driven by its use for more-demanding high-performance applications, have gradually made it a more attractive system for commercial users. UNIX first gained acceptance in academic and research environments with a reputation for being an esoteric system that was difficult to use and thus unsuited to the commercial world.

UNIX, however, currently has its limitations. The primary shortfalls of UNIX are in the areas of large-scale data processing and high-integrity on-line transaction processing (OLTP). These shortfalls are unlikely to permit UNIX to replace mainframe and proprietary operating systems on minis over the next five years. UNIX falls short for a number of reasons: it does not include a transaction-processing monitor; it is not designed for concurrent multiprocessing or fault tolerance; it is weak on data recovery, availability and security; and its file system is not optimised for OLTP. For mission-critical OLTP applications, fault tolerance is often a key requirement.

Stratus has developed its own fault-tolerant version of UNIX, the company's ultimate goal being to develop its UNIX capability to eventu-ally equal or exceed its own proprietary operating system (Virtual Oper-ating System) performance.

Fuelling the thrust of UNIX into OLTP is the growth of networking. The expectation therefore is that UNIX systems will become common as front-end processors for host mainframes. Moreover, the standards organisations such as X/Open, IEEE, OSF and UNIX International have recognised the need for transaction processing support in UNIX, which will give support to its development.

Overcoming all these obstacles will be a time-and-resource-consuming exercise for UNIX software vendors, but one that may be highly profit-able in the expanding OLTP market. The possibility that in time UNIX

will become a viable commercial mainframe operating system faces users with a dilemma. The appearance of the UNIX mainframe option will do much to depress the requirement for non-IBM operating systems. Users will therefore be reluctant to make significant investments in proprietary operating systems when their investments may in a number of years become redundant. These fears may well be overcome by vendors' attempts to make their own systems as open as possible to permit UNIX applications to run on them.

b. Other Non-Proprietary Operating Systems

Two other operating systems have been laying claim to open systems status over the years:

- PICK was developed by Richard Pick as a multi-user machine-independent operating system originally for on-line military stores systems.

- MUMPS was developed out of a system at the Massachusetts General Hospital and has facilities particularly useful in that type of computing environment.

Although both systems have strong followings, neither has been adopted as a universal system the way UNIX has.

- PICK has concentrated on multi-user departmental applications without heavy communications requirements.

- MUMPS has specialised in ease of programming in the complex medical systems field.

Nevertheless, both will continue to be used and will form part of the cohabitation environment of future open systems in which compatibility will be obtained by host/guest arrangements between different operating systems supported across networked systems.

4. Network Control

A major opportunity awaits vendors of network control software since users are dramatically changing the way in which they handle information. Whereas in the past the rapid spread of new personal computers onto the desks of employees was driven by the arrival of new spreadsheet and word processing packages, now organisations are beginning to seek the benefits from collaborative working and the sharing of common databases. Moreover, there is a new realisation that mainframes which provided workers with dumb terminals lacked the ability to give them the tools to do their jobs. There are therefore two sets of forces at work—the drive to network existing standalone PCs and the drive to replace dumb terminals with some form of intelligent workstation.

All over Europe, local-area networks (LANs), are gaining popularity, although growth has been uneven between the different European countries. Users are increasingly requiring sophisticated networking solutions such as local and remote interconnection of LANs and communications to central systems and to other networks and systems.

The United Kingdom currently has the largest number of networked PCs within Europe. Following the explosion of the PC market in the U.S. in 1984/1985, the U.K. became the fastest growth market for PC sales. This has resulted in a large number of standalone PC installations being available for networking. The French and German markets are at a lower level of development and penetration of PC LANs is therefore considerably less.

Both PC and LAN markets are, however, growing rapidly in France and Germany, although Germany has been slower than other countries in Europe to adopt PCs as business tools and to move away from large centralised systems. Once PC LANs are accepted, they have been seen as a valid solution to the question of control. The result is that the German networking market has expanded rapidly in the last two to three years and will continue to do so.

The challenge in providing such networking software is to provide flexibility. Users already will have significant interests in a heterogeneous set of databases, operating systems and equipment. Rarely will such combinations be duplicated between any two sets of users. New networking systems will therefore have to interface with whatever systems a company already has.

Inevitably this implies a strong need for consultancy services as networks and applications are tailored to meet specific client needs. Network complexity means that user organisations are relying increasingly upon the consultancy and programming skills of software companies to install large networks.

D

Operations Management Tools

Operations management tools and utilities include operating system performance monitoring, job scheduling, user control, resource chargeback systems, security/auditing systems, tape and disk I/O optimisers, and network management and communications monitoring programs. At the level of workstations and PCs, this subsector includes products such as disk management utilities. The market forecast for the operations management tools market in Western Europe is shown in Exhibit III-11.

The market for operations management tools is being driven by the complexity of IS data centre management, the shortage of skilled employees, and the perceived need to address these problems with a lower-

cost automated solution that has increasing levels of built-in intelligence. In addition, a potentially major market opportunity exists for software products to manage local-area networks (LANs), and for intra- and inter-network, multivendor management. Earlier generations of LAN operating systems products did not have strong network management capabilities. Much more sophisticated products, with built-in problem-solving capabilities that can monitor remote data centres and networks at one central automated control site will be provided in the future.

The most extensive use of operations management tools is in the main-frame sector, although this sector is forecast to grow at the slowest rate. Over 60% of end-user expenditure in 1990 was expended in the main-frame sector, a fact that reflects not only the generally greater per-unit software product expenditure on mainframes but also Digital's inclusion of such aids within the operating system licence on minicomputer systems (in contrast to non-provision by IBM on mainframes).

Further opportunities exist in the mainframe sector for more-comprehensive automation of the monitoring process and network control programs. Additionally there is further scope for resource cost systems used for allocating information services costs across different cost centres within an organisation.

EXHIBIT III-11

Operations Management Tools
Market Forecast

Subsector	Western European User Expenditures ($ Millions)				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	1,200	1,370	1,520	10	2,250
Minicomputer	570	670	790	18	1,540
Workstation/PC	55	85	120	41	480
Total	1,825	2,125	2,430	15	4,270

User organisations have invested in operations management tools to improve utilisation of existing capacity and to reduce staffing levels. The development of unmanned or "lights-out" computer centres, ideally in remote sites with low facility costs, demands comprehensive and effective operations management aids.

In the minicomputer sector the operations management tools market will be affected by the anticipated growth in distributed processing solutions, network management and monitoring programs. Utilising these tools to form part of an intelligent network (one with distributed communications control) should be a major growth opportunity for minicomputer-based operations management software.

The workstation/PC sector of the market will show the highest growth as these platforms are drawn into the intelligent network systems of the future. Products in this environment include network management software and micro-resource management software.

The major suppliers of operations management tools include not only the major equipment vendors but independent software products vendors. Leading independents active in the European market include:

- Candle
- Computer Associates
- Goal
- Legent
- Software AG

Vendors are under pressure to provide more-comprehensive services to their clients. Whereas vendors, such as Candle Corporation, were once able to simply gain sales over the phone, now the demand is for extensive support and training services in line with the increasing complexity of the products and the environment. Purchasing managers continually question the need for diverse suppliers and prefer to limit procurement to a few vendors with a comprehensive product range. In consequence those vendors that can cover the entire span of a user's requirements—for example, in performance monitoring—will achieve a stronger market position. Utilising advanced languages and software development tools to create products for niche markets will also be an important factor in this market.

As data centre management systems become more complex and more powerful, providing the ability to monitor and automatically control multiple sites from remote locations, so the costs of software corruption become ever greater. Software product vendors are therefore having to consider using encryption methodologies in order to restrict local staff from designing and adding their own "fixes."

Suppliers need also to make products more user friendly. The widespread use of PC applications and the steady emergence of common user access has meant users have far greater expectations for the look and feel of a piece of software.

The overall goal of operations management tools is to provide a comprehensive range of secure, easy-to-use products that extend the unattended operational capability of a system, increase the quality of service from the information system and reduce staffing costs.

E

Applications Development Tools

Applications development tools are projected to be the fastest-growing segment in the systems software market. These tools include relational database management systems (RDBMSs) and related 4GL support tools, computer-aided software engineering (CASE) solutions, knowledge-based development environments, and object-oriented programming and database systems, as well as traditional third-generation programs and general utility packages.

The market for applications development software products is being driven by the tremendous need to improve the productivity of software development as well as the maturing capabilities of application development technologies, such as CASE, 4GL/RDBMS and expert systems (including much more sophisticated CASE integration strategies). The endorsement of CASE by IBM, through its introduction of AD/Cycle and the MVS repository product in 1990, should also help convince potential users of the legitimacy of this market but it is likely that the full impact will not be realised until the end of the forecast period.

Also driving this market is the increasing complexity of software product development requirements. The more complete CASE solutions, for example,.can improve upon the quality of the product as well as improve the efficiencies of development with reusable code. Industry studies show that between 50% and 70% of users' development budgets are concerned with program maintenance. Reverse-engineering CASE products, which have begun to appear over the past few years, could significantly improve the efficiencies of software maintenance. Standards need to be developed in the CASE community and this issue is beginning to be seriously addressed.

A future direction in application development tool products is the integration of the various application development technologies into an I-CASE environment, centred around a CASE repository that includes the capability for reverse engineering. This area is discussed further in Chapter V.

Exhibit III-12 provides an analysis of the forecast growth of the application development tools market for the three equipment platform subsectors.

EXHIBIT III-12

Applications Development Tools
Market Forecast

Subsector	Western European User Expenditures ($ Millions)				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	1,500	1,620	1,770	11	2,600
Minicomputer	1,120	1,300	1,560	19	3,100
Workstation/PC	780	985	1,260	29	3,550
Total (rounded)	3,400	3,900	4,590	19	9,350

The market for the workstation/PC sector is projected to grow more rapidly than for other equipment platforms. This growth reflects a trend in CASE technology toward workstation/PC-based application development with front-end design/prototype activities as well as application code generation performed on the workstation. CGI, the leading French software products vendor, has followed this route with the development of its PACBASE system.

Also, SQL-based data query and report-generation tools are rapidly being transferred to the workstation/PC server-based DBMS environment, with endorsements from large software products vendors such as Ashton-Tate and Microsoft. The trend to co-operative processing models, where the workstation does much of the front-end application processing and the mainframe is utilized more for on-line transaction processing and network management, will facilitate the trend towards the workstation/PC platforms for application development. Application development for IBM's System Application Architecture (SAA) environment will also be able to more effectively utilize workstation/PCs as development platforms, because of the portability concept of the architecture.

The growth in the market for minicomputer-based application development tools is based upon the assumption that the minicomputer will become a major platform of choice in the server portion of the client/server distributed processing model and the anticipated expansion of the

use of 4GLs such as FOCUS, Powerhouse, and Mantis for applications utilising multivendor database access. In addition, several proposed CASE solutions (including DEC's CDD/Plus and IBM's AD/Cycle) will utilise the VAX/VMS and AS/400 platforms.

The mainframe market for application development tools is projected to show the lowest level of growth relative to the other categories of equipment platform with a forecast five-year CAGR of only 11%. Currently much of the backend application development in CASE is being done on mainframes. The IBM MVS/Repository CASE product should also be a plus in using mainframes for I-CASE solutions.

In general the growth in application development tools will be driven by the need to improve productivity in the development of applications. Application users throughout Europe are facing two closely connected problems. The first is a significant backlog in the development of applications. This backlog results from an increased demand for business systems as computerisation spreads into new areas of the business and as business needs are now changing faster than systems can be developed or adapted. The second is an increasing shortage of skilled programmers, especially in the newer fourth-generation languages. As new systems are added, the requirement for maintenance increases. This requirement, together with the need for new systems, is intensifying the need to improve programmer productivity. The need, therefore, is to find ways to overcome manpower resource problems; the improvements claimed for the newer development tools are seen as one way of overcoming this obstacle.

The market sizes and growth rates for the major categories of applications development software products—database management systems (DBMSs), 3GLs, 4GLs, computer-aided software engineering (CASE) and knowledge-based systems (KBSs)—are shown in Exhibit III-13. Object-orientated technology is split into two parts: object-orientated programming is included in the "others" category and object-orientated database systems are included in DBMS. CASE tools and knowledge-based systems are predicted to exhibit the fastest growth within the sector.

EXHIBIT III-13

Applications Development Software Products Market

Software Product Category	Western European User Expenditures ($ Millions)			
	1989	1990	1990-1995 CAGR (Percent)	1995
Database Management System (DBMS)	1,800	2,030	16	4,300
3GL	900	975	11	1,680
4GL	470	570	20	1,390
CASE	160	240	42	1,380
Knowledge-Based System	40	50	43	300
Other	30	40	38	200
Total (rounded)	3,400	3,900	19	9,250

1. Database Management Systems

The growth of database management systems is forecast to slow considerably over the next five years. This slowness has resulted from a saturation of the market in the mainframe sector. Demand for these products is now largely of a replacement rather than a new-demand nature. This follows impressive growth during the late 1980s largely as a result of soaring demand for relational databases. Independent vendors are experiencing reduced growth rates in their demand for systems as a result of bundling by equipment manufacturers. IBM has already done this with its OS/400 and OS/2 EE announcements, including these with operating systems, and DEC has also offered bundled run-time versions of its DBMS product.

The database is also being used in new ways. Whilst databases were once simply considered as data storage, they are now being used as a key

tool in applications, particularly as the user interface is simplified. The result, therefore, is that competition in this area is intensifying as vendors have had to become more involved in the applications. Oracle has been particularly strong in this respect.

Market opportunities for mainframe platforms are forecast to be limited, firstly since mainframe installations are virtually static and secondly since IBM has rapidly established DB2 as the standard for its equipment. Significantly greater opportunities do, however, exist in the mid-range market where, for instance, only 25% of Digital VAX machines have a database installed.

Whilst the total database market is forecast to report a slow-down in growth over the period 1990 to 1995, one growth segment in this area will be the move to distributed databases. The potential for growth will be dependent upon the ability of vendors to provide solutions and the capabilities of user organisations to adopt them.

There is a clear move towards distributed information processing based on relational database architectures. A distributed database system is a collection of databases or parts of a database which appear to the user to be one database. To the user, the location of the data, stored on hetero-geneous equipment platforms, does not matter. True distributed data-bases provide transparent, seamless processing across heterogeneous environments. What will emerge, therefore, will be enterprise-wide computing networks with applications that will be able to access and update databases across multiple heterogeneous equipment platforms. These databases will be distributed over multiple networks—both wide area and local area.

At present no vendor provides the transparent seamless processing across heterogeneous environment that a truly distributed database implies. Vendors, however, are moving in that direction, mainly in the areas of remote query processing, distributed update processing and the client/ service architecture. Models of distributed processing, which provide for updating and retrieving data across multiple databases, include those from Sybase, Oracle and Ingress Corp. Oracle Corp intends to provide distributed DBMS products in a variety of environments, which include MVS, VM, DOS, OS/2 and UNIX. IBM intends to extend its relational SAA products to provide access to distributed relational data through the SQL interface. Similarly, Software AG is looking towards distributed database functionality.

The relational database market is under threat from the newer object-orientated technology. Whereas relational and object-orientated data-bases offer flexibility, applications based on the latter are claimed to be easier to maintain because so much of the software can be reused. Since maintenance absorbs so much of the costs of human resources, there are

clear advantages over relational types. Moreover, it is claimed that object-orientated technology addresses the major problem of reliability. The challenge, therefore, for database suppliers is to match this market potential. Whilst Ingres and Software AG have made a move to market object-oriented systems, a number of smaller organisations are also gaining market share. These are Ontologic, Object Design, Servo Logic and Object-Sciences.

2. Third- and Fourth-Generation Language Systems

The market for fourth-generation languages (4GLs) is following a similar pattern to that for third-generation languages: initial rapid growth and a multitude of vendors entering the market, followed by a period of consolidation when the number of vendors falls significantly and growth rates decline.

Third-generation languages resulted from the need to improve productivity at a time when the price performance of computers was rapidly falling and the human element became the most significant factor in development costs. It is this need to increase productivity that has given rise to the development of subsequent fourth-generation languages and CASE tools. In the late 1960s, 120 or more 3GLs were in existence, but few of these have survived into the 1990s.

A similar pattern is forecast for fourth-generation languages. 4GLs brought with them new concepts such as prototype and end-user computing. Heralded as another means to end the application development backlog, it was claimed that productivity gains of five to ten times could be achieved over the use of third-generation languages. The result was that the market grew from a handful of products in the early 1980s to several hundred. Just as the market for third-generation languages consolidated to a few products, so the market for fourth-generation languages is likely to follow.

Despite the rapid growth of CASE tools, both 3rd- and 4th-generation language markets will grow over the next five years, although at a lower rate than that expected for CASE.

Traditional software development requires considerable duplication of tasks. Object-orientated programming is said to overcome this duplication. Whilst object-orientated programming currently occupies a very small part of the market, there is an identifiable trend towards object-orientated programming languages.

As a complete language technology, object-orientated programming was first introduced by Xerox with its Smalltalk product. AT&T added object-orientated features to C to create C++. Smalltalk and C++ are now the dominant object-orientated languages. Ingres, however, has an-

nounced what it claims to be the world's first object-orientated fourth-generation language.

3. CASE

The advantages CASE confers extend beyond the initial design and implementation of applications. They extend over the whole application lifecycle. If it were merely the objective to generate more code, then 4GLs would be the answer with their advantage of user friendliness in development. Software maintenance, which in some instances consumes up to 70% of application development budgets, is increasingly pushing development teams down one of two routes. The first is the purchase of standard packaged application solutions. Where these are not available, do not provide the flexibility to change or are not suitable for strategic implementations, then companies are looking to I-CASE methods to develop their own applications. Such users will become major beneficiaries from implementation of I-CASE application development programs. CASE, it is claimed, will be a means to resolve end-user dissatisfaction with the timescales, cost and quality of delivered systems.

Integration of all the design and database elements into a common repository is essential to the reverse-engineering capability, which will address the problems encountered in maintenance. The announcement by IBM of AD/Cycle is a clear pointer to the future. IBM has made it clear that the repository will be a key component in the productivity strategy in any company committed to IBM systems.

The average growth of CASE tools markets across Europe is forecast to be 40% per annum between 1990 and 1995. The UK market is considered to be likely to rapidly grow based on a relatively low level of market penetration today. The French and German markets are expected to grow slowly, the French market in particular being already well developed. A very rapid increase in the acceptance of CASE tools is also being experienced in Spain.

A major problem in the adoption of CASE has been the lack of standards in this area. This has largely resulted from the absence of any one major vendor in this field. However, as CASE standards emerge and the various application development technologies are integrated into an I-CASE environment based around a repository, so the adoption of CASE tools is anticipated to increase. The announcement by IBM of AD/Cycle has validated the CASE philosophy, although questions have been raised about when IBM will be able to deliver the complete product. Moreover, the announcement is placing pressure on the other equipment manufacturers—such as ICL, Digital and Bull—to define their strategies.

F
Competitive Environment

Exhibit III-14 lists the leading systems software products vendors in the Western European market in 1989. It is evident from this categorisation that equipment vendors held a dominating position in this market, notably IBM with around one quarter of the entire market. This positioning relates to the fact that systems control software (which represents the largest segment of the systems software market) has been, historically, largely a proprietary offering of computer systems vendors. In contrast the application development tool market (the second largest segment) includes a number of independent software product developers as market leaders. The faster growth being realised in this subsector is witnessed by the fast growth of companies such as Oracle and Software AG.

Digital is the second largest supplier of systems software products in Europe. INPUT has estimated that were Digital's VAX system software products unbundled, and assuming the same equipment installed base, Digital would effectively have generated a further $400 million in annual revenues in 1989. This would have taken the volume of Digital's business in this market to about half that generated by IBM. Digital includes either VMS or UNIX (which is now of growing importance to the company) and DECNET networking software bundled into the equipment. Further products purchased separately would typically be the database dictionary, 4GLs and compilers. VMS typically comes bundled with all the systems management software required.

Computer Associates (CA), is the world's largest independent computer software products company. CA supplies system software packages which cover everything from program testing to controlling several computers from a single console. In Europe, CA has a decentralised structure with no European headquarters. Revenue from each major European market—France, Germany, Italy and the United Kingdom—is approximately equal ($100 million per country in 1989, of which over half is accounted for by system software products).

Oracle is best known for its relational database products. The company has enjoyed phenomenal growth over the previous decade, having failed to double its revenues in only one of the previous ten years. This growth in now under threat as the relational database market growth begins to slow down.

EXHIBIT III-14

Leading System Software Product Vendors Western Europe, 1989

Rank	Vendor	Estimated Market Share (Percent)*	Estimated Revenue ($ Millions)
1	IBM	25	2,255
2	Digital	8	700
3	Siemens	6	560
4	Bull	4	360
5	Computer Associates	2	215
6	Unisys	2	220
7	ICL	2	200
8	Oracle	2	195
9	Novell	2	170
10	Software AG	2	155
	Others	45	4,110
	Total	100	9,140

*Rounded.

Also, as early entrants to the relational database market, new organisations such as Sybase have been able to exploit earlier entrants' product limitations and design faster databases from scratch without the costly need to amend existing ones.

Oracle has therefore changed its strategy and is now diversifying into other product areas. Recently it has made significant investments in the applications software market, although it has yet to take significant revenues for these products and become established as an applications software vendor. Consultancy also, on a worldwide basis, provides £100 million in revenue for Oracle. These consultancy services are seen as a

way to ensure the user selects its database program as the basis of networked applications.

Exhibits III-15 through III-19 provide listings of the leading system software product vendors in, respectively, France, Germany, the United Kingdom, Italy and Spain.

EXHIBIT III-15

Leading System Software Product Vendors France, 1989

Rank	Vendor	Estimated Market Share (Percent)*	Estimated Revenue (FF Millions)
1	IBM	18	2,230
2	Bull	9	1,120
3	Digital	7	910
4	Computer Associates	3	360
5	Unisys	2	280
6	Oracle	2	220
7	CGI	2	190
8	Novell	2	190
9	ICL	1	130
10	Microsoft	1	105
	Others	61	7,145
	Total Market	100	12,150

*Rounded.

EXHIBIT III-16

Leading System Software Product Vendors
Germany, 1989

Rank	Vendor	Estimated Market Share (Percent)*	Estimated Revenue (DM Millions)
1	IBM	26	900
2	Siemens	21	720
3	Digital	8	270
4	Computer Associates	3	100
5	Software AG	3	90
6	Novell	2	80
7	Oracle	2	70
8	Unisys	2	60
9	Bull	1	4
10	Microsoft	1	35
	Others	32	1,130
	Total Market	100	3,500

*Rounded.

EXHIBIT III-17

Leading System Software Product Vendors
United Kingdom, 1989

Rank	Vendor	Estimated Market Share (Percent)*	Estimated Revenue (£ Millions)
1	IBM	27	260
2	Digital	18	170
3	ICL	15	145
4	Unisys	4	40
=5	Computer Associates	3	30
=5	Oracle	3	30
7	Siemens	3	25
=8	Novell	2	20
=8	Bull	2	20
10	Software AG	1	10
	Others	22	210
	Total Market	100	960

*Rounded.

EXHIBIT III-18

Leading System Software Product Vendors
Italy, 1989

Rank	Vendor	Estimated Market Share (Percent)*	Estimated Revenue (Lira Billions)
1	IBM	28	480
2	Digital	6	100
3	Bull	5	80
4	Olivetti	4	60
5	Computer Associates	3	50
6	Unisys	2	30
7	Siemens	2	28
8	Finsiel	1	25
9	Novell	1	23
10	Oracle	1	21
	Others	47	803
	Total Market	100	1,700

*Rounded.

EXHIBIT III-19

Leading System Software Product Vendors
Spain, 1989

Rank	Vendor	Estimated Market Share (Percent)*	Estimated Revenue (Pta Millions)
1	IBM	30	10,200
2	Centro Calculo	8	2,650
3	Software AG	5	1,850
4	Unisys	5	1,560
5	Siemens	4	1,450
6	Ibermatica	3	1,170
=7	Digital	2	780
=7	Oracle	2	780
9	Bull	2	680
10	Olivetti	2	680
	Others	35	12,200
	Total Market	100	34,000

*Rounded.
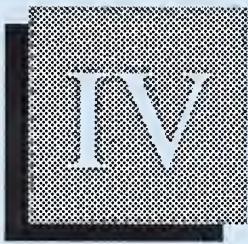
IV

Country Market Analysis
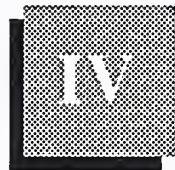
Country Market Analysis

This chapter contains comparative market size data for Western Europe as well as data on individual country markets.

Exhibit IV-1 shows a comparison of the country markets for systems software products in Western Europe converted into U.S. dollars and rounded. The exchange rates used are listed in Appendix B. Exhibit IV-2 is a table that shows the overall Western European market analysed by subsector. The remaining exhibits in this chapter provide individual-country data in the same format as Exhibit IV-2. These tables, Exhibits IV-3 through IV-16, are ordered as the countries are listed in Exhibit IV-1, i.e.: Exhibit IV-3 is for France and Exhibit IV-16 is for the rest of Western Europe. The rest of Western Europe is defined as comprising Greece, Portugal and Ireland.

The database by country for the three subsectors of mainframe, mini-computer and workstation/PC shows year-on-year growth for the period 1989 through to 1995 and is included in the Appendixes to this report. Appendix C provides the data in local currency, Appendix D in ECUs.

EXHIBIT IV-1

Systems Software Products
Comparative Country Markets
Western Europe

Country	Western European User Expenditures ($ Millions)			
	1989	1990	1990-1995 CAGR (Percent)	1995
France	1,970	2,290	14	4,450
Germany	1,930	2,180	16	4,640
United Kingdom	1,520	1,660	16	3,490
Italy	1,270	1,440	16	2,990
Sweden	270	300	15	610
Denmark	200	230	15	450
Norway	160	180	15	370
Finland	160	180	15	360
Netherlands	490	550	14	1,060
Belgium	280	310	14	600
Switzerland	330	380	14	740
Austria	180	200	14	380
Spain	290	340	17	740
Rest of Europe	90	110	15	220
Total	9,140	10,350	16	21,100

EXHIBIT IV-2

System Software Market Forecast
Western Europe

Subsector	$ Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	5,000	5,410	5,890	9	8,250
Systems Control Products	2,300	2,420	2,600	7	3,400
Operations Management	1,200	1,370	1,520	10	2,250
Application Development	1,500	1,620	1,770	10	2,600
Minicomputer	2,680	3,120	3,670	18	6,990
Systems Control Products	990	1,150	1,320	15	2,350
Operations Management	570	670	790	18	1,540
Application Development	1,120	1,300	1,560	19	3,100
Workstation/PC	1,460	1,820	2,300	26	5,860
Systems Control Products	625	750	920	20	1,830
Operations Management	55	85	120	41	480
Application Development	780	985	1,260	29	3,550
Total	9,140	10,350	11,860	16	21,100
Subtotals					
Systems Control Products	3,915	4,320	4,840	12	7,740
Operations Management	1,825	2,125	2,430	15	4,320
Application Development	3,400	3,905	4,590	19	9,350

EXHIBIT IV-3

System Software Market Forecast
France

Subsector	FF Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	6,450	7,150	7,700	7	10,000
Systems Control Products	2,900	3,150	3,300	6	4,200
Operations Management	1,600	1,850	2,100	9	2,800
Application Development	1,950	2,150	2,300	7	3,000
Minicomputer	3,700	4,450	5,200	16	9,300
Systems Control Products	1,350	1,600	1,830	14	3,050
Operations Management	790	950	1,120	16	2,000
Application Development	1,560	1,900	2,250	17	4,250
Workstation/PC	2,000	2,550	3,150	26	8,200
Systems Control Products	800	1,000	1,200	20	2,500
Operations Management	120	150	200	41	850
Application Development	1,080	1,400	1,750	28	4,850
Total	12,150	14,150	16,050	14	27,500
Subtotals					
Systems Control Products	5,050	5,750	6,330	11	9,750
Operations Management	2,510	2,950	3,420	14	5,650
Application Development	4,590	5,450	6,300	17	12,100

EXHIBIT IV-4

System Software Market Forecast
Germany

Subsector	DM Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	2,000	2,170	2,400	11	3,600
Systems Control Products	900	965	1,050	9	1,500
Operations Management	500	565	650	12	1,000
Application Development	600	640	700	11	1,100
Minicomputer	1,000	1,160	1,370	19	2,750
Systems Control Products	370	435	500	17	950
Operations Management	220	265	320	20	650
Application Development	410	460	550	20	1,150
Workstation/PC	500	625	790	27	2,040
Systems Control Products	220	280	360	22	750
Operations Management	20	25	30	37	120
Application Development	260	320	400	30	1,170
Total	3,500	3,955	4,560	16	8,390
Subtotals					
Systems Control Products	1,490	1,680	1,910	14	3,200
Operations Management	740	855	1,000	16	1,770
Application Development	1,270	1,420	1,650	19	3,420

EXHIBIT IV-5

System Software Market Forecast
United Kingdom

Subsector	£ Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	520	545	595	9	840
Systems Control Products	245	250	260	7	350
Operations Management	120	130	150	11	220
Application Development	155	165	185	10	270
Minicomputer	280	315	370	18	720
Systems Control Products	105	115	135	16	240
Operations Management	60	70	80	18	160
Application Development	115	130	155	20	320
Workstation/PC	160	190	240	27	640
Systems Control Products	70	80	95	20	200
Operations Management	5	10	15	43	60
Application Development	85	100	130	31	380
Total	960	1,050	1,205	16	2,200
Subtotals					
Systems Control Products	420	445	490	12	790
Operations Management	185	210	245	16	440
Application Development	355	395	470	20	970

EXHIBIT IV-6

System Software Market Forecast
Italy

Subsector	Lira Billions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	850	910	980	8	1,350
Systems Control Products	400	420	440	6	560
Operations Management	200	220	240	11	370
Application Development	250	270	300	9	420
Minicomputer	530	615	730	18	1,400
Systems Control Products	200	230	260	15	460
Operations Management	110	130	155	18	300
Application Development	220	255	315	20	640
Workstation/PC	320	400	505	26	1,250
Systems Control Products	130	150	175	17	330
Operations Management	10	20	30	38	100
Application Development	180	230	300	29	820
Total	1,700	1,925	2,215	16	4,000
Subtotals					
Systems Control Products	730	800	875	11	1,350
Operations Management	320	370	425	16	770
Application Development	650	755	915	20	1,880

EXHIBIT IV-7

System Software Market Forecast
Sweden

Subsector	SK Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	1,020	1,110	1,220	10	1,790
Systems Control Products	470	500	540	8	730
Operations Management	245	275	310	13	500
Application Development	305	335	370	11	560
Minicomputer	425	495	585	17	1,080
Systems Control Products	160	180	205	14	350
Operations Management	90	105	125	17	230
Application Development	175	210	255	19	500
Workstation/PC	255	325	410	26	1,030
Systems Control Products	110	130	155	18	300
Operations Management	10	15	20	43	90
Application Development	135	180	235	29	640
Total	1,700	1,930	2,215	15	3,900
Subtotals					
Systems Control Products	740	810	900	11	1,380
Operations Management	345	395	455	16	820
Application Development	615	725	860	19	1,700

EXHIBIT IV-8

System Software Market Forecast
Denmark

Subsector	DK Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	650	700	750	7	990
Systems Control Products	300	320	340	6	420
Operations Management	160	175	190	9	270
Application Development	190	205	220	8	300
Minicomputer	485	565	655	15	1,150
Systems Control Products	175	200	225	13	370
Operations Management	110	125	140	14	240
Application Development	200	240	290	18	540
Workstation/PC	270	340	430	26	1,060
Systems Control Products	120	140	165	18	320
Operations Management	5	10	15	52	80
Application Development	145	190	250	28	660
Total	1,405	1,605	1,835	15	3,200
Subtotals					
Systems Control Products	595	660	730	11	1,110
Operations Management	275	310	345	14	590
Application Development	535	635	760	19	1,500

EXHIBIT IV-9

System Software Market Forecast
Norway

Subsector	NK Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	595	635	690	8	940
Systems Control Products	275	285	300	6	390
Operations Management	145	160	175	10	260
Application Development	175	190	215	9	290
Minicomputer	345	405	475	18	925
Systems Control Products	125	145	165	16	300
Operations Management	75	85	100	17	190
Application Development	145	175	210	20	435
Workstation/PC	165	205	255	25	635
Systems Control Products	75	85	100	18	195
Operations Management	5	10	15	43	60
Application Development	85	110	140	28	380
Total	1,105	1,245	1,420	15	2,500
Subtotals					
Systems Control Products	475	515	565	11	885
Operations Management	225	255	290	15	510
Application Development	405	475	565	18	1,105

EXHIBIT IV-10

System Software Market Forecast
Finland

Subsector	FM Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	355	380	405	7	530
Systems Control Products	160	170	180	5	220
Operations Management	85	95	105	10	150
Application Development	110	115	120	7	160
Minicomputer	195	230	265	17	500
Systems Control Products	75	85	95	15	170
Operations Management	40	50	60	17	110
Application Development	80	95	110	18	220
Workstation/PC	115	145	190	27	470
Systems Control Products	50	60	75	18	140
Operations Management	5	5	10	43	30
Application Development	60	80	105	30	300
Total	665	755	860	15	1,500
Subtotal					
Systems Control Products	285	315	350	11	530
Operations Management	130	150	175	14	290
Application Development	250	290	335	19	680

EXHIBIT IV-11

System Software Market Forecast
Netherlands

Subsector	Dfl Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	550	590	635	8	860
Systems Control Products	245	260	275	6	350
Operations Management	135	150	165	10	240
Application Development	170	180	195	8	270
Minicomputer	290	335	395	17	735
Systems Control Products	105	120	140	15	240
Operations Management	60	70	80	17	155
Application Development	125	145	175	19	340
Workstation/PC	160	200	255	25	605
Systems Control Products	65	80	100	18	180
Operations Management	5	10	15	38	50
Application Development	90	110	140	28	375
Total	1,000	1,125	1,285	14	2,200
Subtotals					
Systems Control Products	415	460	515	11	770
Operations Management	200	230	260	14	445
Application Development	385	435	510	18	985

EXHIBIT IV-12

System Software Market Forecast
Belgium

Subsector	BF Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	5,900	6,310	6,750	7	9,050
Systems Control Products	2,700	2,840	2,980	5	3,700
Operations Management	1,450	1,580	1,720	10	2,500
Application Development	1,750	1,890	2,050	9	2,850
Minicomputer	3,100	3,600	4,200	16	7,700
Systems Control Products	1,140	1,300	1,460	14	2,500
Operations Management	700	800	950	16	1,650
Application Development	1,260	1,500	1,790	19	3,550
Workstation/PC	1,600	1,990	2,450	24	5,950
Systems Control Products	700	820	950	17	1,800
Operations Management	50	70	90	38	350
Application Development	850	1,100	1,410	28	3,800
Total	10,600	11,900	13,400	14	22,700
Subtotals					
Systems Control Products	4,540	4,960	5,390	10	8,000
Operations Management	2,200	2,450	2,760	13	4,500
Application Development	3,860	4,490	5,250	18	10,200

EXHIBIT IV-13

System Software Market Forecast
Switzerland

Subsector	SF Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	315	340	370	8	510
Systems Control Products	145	150	160	7	210
Operations Management	75	85	95	10	140
Application Development	95	105	115	9	160
Minicomputer	150	175	205	17	390
Systems Control Products	55	65	75	14	125
Operations Management	30	35	40	18	80
Application Development	65	75	90	20	185
Workstation/PC	120	150	195	14	290
Systems Control Products	75	95	125	0	90
Operations Management	-	5	10	32	20
Application Development	40	50	60	29	180
Total	585	665	770	12	1,190
Subtotals					
Systems Control Products	275	310	360	7	425
Operations Management	110	125	145	14	240
Application Development	200	230	265	18	525

EXHIBIT IV-14

System Software Market Forecast
Austria

Subsector	Sch Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	1,220	1,300	1,390	7	1,800
Systems Control Products	560	585	615	5	740
Operations Management	300	325	355	9	500
Application Development	360	390	420	8	560
Minicomputer	675	775	900	16	1,650
Systems Control Products	255	285	320	13	525
Operations Management	135	155	180	17	340
Application Development	285	335	400	19	785
Workstation/PC	360	455	570	24	1,350
Systems Control Products	155	185	220	17	400
Operations Management	15	20	25	35	90
Application Development	190	250	325	28	860
Total	2,255	2,530	2,860	14	4,800
Subtotals					
Systems Control Products	970	1,055	1,155	10	1,665
Operations Management	450	500	560	13	930
Application Development	835	975	1,145	18	2,205

EXHIBIT IV-15

System Software Market Forecast
Spain

Subsector	Pta Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	18,500	20,000	22,100	10	32,500
Systems Control Products	8,400	9,000	9,800	9	13,600
Operations Management	4,600	5,000	5,600	12	8,800
Application Development	5,500	6,000	6,700	11	10,100
Minicomputer	10,200	12,150	14,600	20	30,200
Systems Control Products	3,800	4,500	5,300	18	10,100
Operations Management	2,100	2,450	2,900	20	6,100
Application Development	4,300	5,200	6,400	22	14,000
Workstation/PC	5,300	6,750	8,600	28	23,100
Systems Control Products	2,300	2,800	3,400	20	7,000
Operations Management	150	250	400	45	1,600
Application Development	2,850	3,700	4,800	31	14,500
Total	34,000	38,900	45,300	17	85,800
Subtotals					
Systems Control Products	14,500	16,300	18,500	13	30,700
Operations Management	6,850	7,700	8,900	16	16,500
Application Development	12,650	14,900	17,900	21	38,600

EXHIBIT IV-16

System Software Market Forecast
Rest of Europe

Subsector	$ Millions				
	1989	1990	1991	1990-1995 CAGR (Percent)	1995
Mainframe	60	65	70	7	90
Systems Control Products	35	35	35	3	40
Operations Management	5	10	10	15	20
Application Development	20	20	25	8	30
Minicomputer	30	35	40	19	85
Systems Control Products	15	15	15	15	30
Operations Management	5	5	5	32	20
Application Development	10	15	20	18	35
Workstation/PC	5	10	15	38	50
Systems Control Products	5	5	10	25	15
Operations Management	0	0	0	0	5
Application Development	0	5	5	43	30
Total	95	110	125	15	225
Subtotals					
Systems Control Products	55	55	60	9	85
Operations Management	10	15	15	25	45
Application Development	30	40	50	19	95
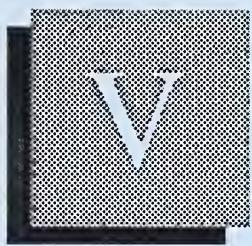
Software Products
Technology/Market Trends

V
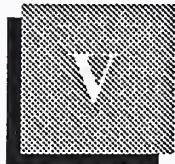
Software Products Technology/ Market Trends

This chapter discusses current directions in software products technology. Three major areas of importance are addressed as follows:

- Co-operative/distributed data processing
- Application development tool technology
- Standards

A
Co-operative/ Distributed Data Processing

1. Client/Server Implementation

Much of the next generation of networked software products will be based on a client/server architecture. Although an industry definition of a client/server architecture is still evolving, the general concept involves matching a particular data processing task to the appropriate machine for execution. The database and communications portions of an application are usually executed on the server. These portions also provide the desktop/client with access to other distributed network-based software and hardware applications/resources on an interactive/dynamic execution basis in a network environment. The utility software on the server can provide connectivity with remote databases, manage network communication, and provide data translation among diverse data types. A client/server implementation of a co-operative processing solution also usually implies the utilization of a hierarchical (terminal/workstation to host) processing interchange. Exhibit V-1 illustrates a generic client/server model.

The benefits of utilizing a database server include increased accessibility of distributed databases for report generation as well as for distributed application access. In addition, a programmable database server architecture, in particular, can reduce the complexity of database structuring and maintenance for the application developer.

The lack of a common industry definition is one of a number of issues surrounding the implementation of client/server software products solutions, which will negatively impact the rate of transition to this new delivery mode. Some other issues are discussed below.

One such issue is the lack of product models that help define appropriate software applications for product migration. The few models that exist are primarily in the application development product category, such as CASE, knowledge-based systems, and text management development systems.

EXHIBIT V-1

Client/Server Model

Client (Desktop)	CUA	Front-end Application	4GL Tool Set
	APIs		

Server	Gateways	DBMSs	Server Applications

Source: Sybase
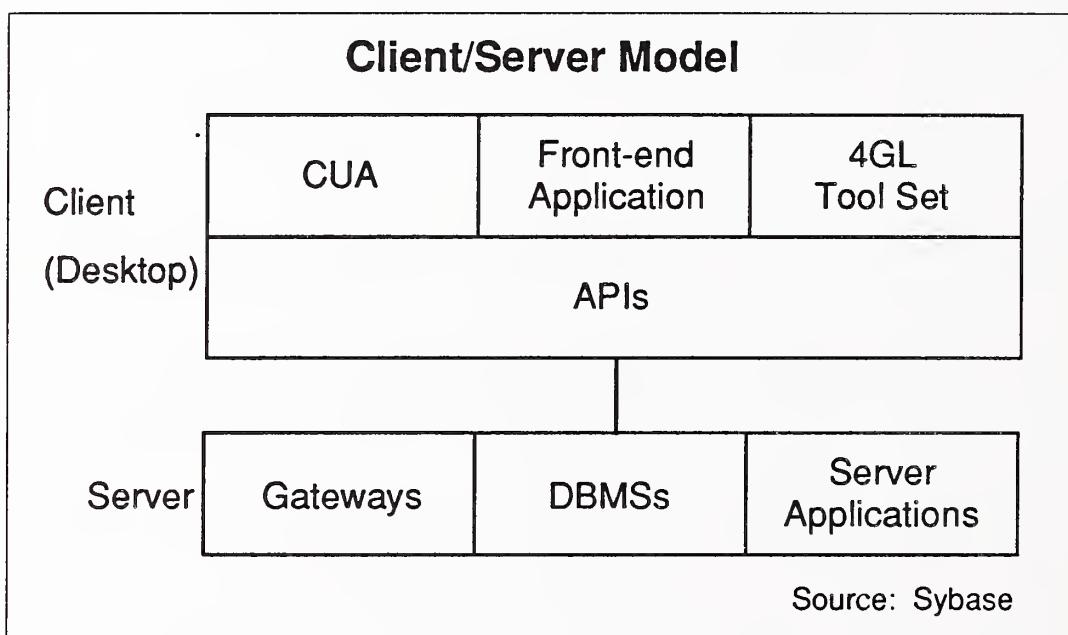
The transition to the client/server model from standalone applications and file-server-based LANs will require complete rewrites of many current products (in modular form); this may involve significant incremental product development and implementation costs. Recently, however, some more-appealing—and less-costly—migration paths have appeared that involve the utilization of current applications with Windows interfaces and application programming interfaces, which provide access to a number of server environments.

Implementing multiserver communications ultimately involves the utilization of multiple layers (including several layers at the interapplication level) of a networking protocol stack standard (such as ISO/OSI) or building extensive gateways to bridge disparate protocols supported by the various equipment and applications vendors. Currently, there is considerable industry-wide support for the lower communication protocol layers, such as TCP/IP, Ethernet, and Token-Ring (including bridges, routers and other types of gateways). However, upper layers of the ISO/OSI protocol stack are still in the finalisation process, and widespread equipment/applications support is still probably years away. Therefore, the companies implementing multiserver database communi-

cation (Sybase, Oracle, Sun Microsystems, HP, DEC and IBM, in particular) are promoting their own versions of remote messaging that provide for access to heterogeneous vendor database servers. Sybase's Client/Server Interface (C/SI) is based on the ISO Remote Database Access (RDA) protocol and ANSI SQL. Increasingly, such inter-server support will also provide access to both relational and nonrelational data management systems, as well as to application services.

The optimal client and server implementation configuration is still in a speculative stage, due partly to the rapid evolution of hardware designs and systems software tools which are being specifically designed to implement the newly distributed database application models. An optimal server platform for supporting multiple applications should probably be based on a multiprocessing as well as a multiuser/multi- tasking architecture.

Keys to success will also involve acceptance of industry-wide, distributed RDBMS de facto standards that are based on the development of a number of front-end applications by independent software developers. The user interface to RDBMS must also be simplified. The incorporation of a natural-language front-end capability could provide a significant competitive advantage.

Vendors with a background in mainframe and minicomputer platforms appear to be positioning these systems as the database/repository and network servers to a variety of microprocessor-based platforms, where eventually much of the processing segment of the application execution will occur.

Discussions of examples of such client/server models follow.

IBM's SAA architecture uses the PS/2 as an intelligent front-end platform for accessing multihost-based applications through a common-user-access (CUA) graphics interface. The Easel application development product from Interactive Images provides SAA compliance for the OS/2 front-end platform. The ability to access remote applications and data is based on support for IBM's network protocols and database interfaces, including LU6.2 APPC, PU2.1, and SQL. By utilizing IBM's OS/2 EE implementation, the application developer for the PS/2 has a built-in communications and database access toolkit. AS/400 support is also provided for IBM's PROFS integrated office automation architecture.

A number of independent software development companies have indicated that they are developing applications that will be compliant with the SAA distributed architecture under the OfficeVision product definition.

IBM's distributed database strategy is complicated somewhat by its support of four relational database architectures and by its current host-

based hierarchical SNA communications architecture. Industry sources suggest that IBM will support OSI through parallel implementations with SNA and inter-communications based on applications support for IBM's Common Programming Interface for Communications (CPI-C), which will also provide support for multivendor applications in a networking environment.

IBM's DB2 version 2.2 will provide the initial stages of what will likely be an evolutionary rollout of distributed relational database management system products for implementing SAA-based applications. More advanced versions are expected to support remote distributed requests across multiple platforms. IBM's Repository, a part of AD/Cycle, will likely provide a distributed data directory for applications that utilize distributed relational database management access.

IBM's OS/2 Extended Edition (with bundled communications and database management system products) can also be configured as a database server.

IBM's competitors (such as Oracle, INGRES Corp./Relational Technology, Sybase, and Informix) are utilizing a single RDBMS architecture and porting it across multivendor, multiscale platforms. Oracle, for example, provides database servers for IBM MVS, VM, and AIX environments; DEC VMS systems; and UNIX, DOS, Macintosh, and OS/2 platforms. In addition, Oracle is also providing interfaces that will allow users to access Oracle and other database servers from a number of popular desktop applications, such as Lotus 1-2-3, 4th Dimension, HyperCard, Supercard, and dBASEIII Plus.

DEC will provide application toolkits for third-party software developers to interface to its DECnet application services. These tool kits will include Network Application Support (NAS) services to provide access to applications (such as document management and electronic mail) and data that reside on DEC VAX/VMS platforms and eventually those of other vendors. Also included are specifications for writing applications that can be integrated with DEC's multimedia networking-based products and help provide application interoperability across a multivendor desktop environment.

DEC's Compound Document Architecture (CDA) toolkits, which provide a library of interchange standards format conversions for interfacing imaging-based products (text, graphics, and images) for multiple-platform product support, will allow for the interchange of revisable data between users, systems, and standards. CDA is supported as a subset of DEC's NAS. Implementation of applications with the CDA toolkit will allow for the interchange, between vendors, of revisable compound documents across an enterprise. With support for the DEC file interface formats, live links can be established with a variety of DEC network-

based products such as DEC Write, DEC Decision, DEC Image, DEC Chart, and VAX Image Application Services as well as third-party file format standards such as that for Lotus 1-2-3 files.

DEC has also announced that it plans to provide an integration of OS/2 clients and VAX/VMS servers with an OS/2 version of its Personal Computing Systems Architecture (PCSA), which currently supports MS-DOS.

Hewlett-Packards' NewWave graphical user interface and NewWave office development environment provides the following:

- Support for Microsoft Windows under DOS

- Live link integration of DOS applications migrated to the NewWave environment

- Software emulation support for existing standalone DOS applications

- Access from NewWave-based UNIX, MS-DOS and OS/2 programs to HP's network-based applications and relational databases, along with the ability to program through "intelligent agents" reporting sequences under an E-mail network implementation.

Hewlett-Packard is also providing a UNIX version of LAN Manager (the Microsoft network operating system for OS/2) as well as a Presentation Manager implementation on its UNIX platforms that will enhance the use of OS/2 platforms as a front end to Hewlett-Packard-based minicomputer servers.

Computer Associates provides a distributed database architecture with its CA-Datacom/Star product, which allows for an application program to access and update data across its database platforms that utilize its Information Transmission Manager for routing across network nodes.

Vendors with a history in the microprocessor arena tend to support client/ server architecture based on the workstation server model, utilizing OS/2 or UNIX operating systems. One of the better-articulated client/server architectures is Sybase's SQL Open Server product.

Increasingly, workstation hardware is being optimized for a server functionality, including hardware and software, to maximise I/O transaction capability and network management, which now limit PC/workstation-based hardware server solutions, as opposed to minicomputers and mainframes. Multiprocessor (with symmetric multiprocessing) implementations will also address the limitation of being able to efficiently handle multiple-application execution on a server configuration.

Specific server products for client/server co-operative processing include a networked Sun 386i computer system with a hybrid UNIX/DOS operating system attached to a Sun3/280 as a back-end server. Another example is Sybase's SQL Open Server database management software and related software utilities that support the OS/2 VAX/VMS, Sun/UNIX and HP/HP-UX operating systems. With multivendor support for Sybase's C/SI (which is based on the ISO remote database access model), client-based applications can access data across multivendor platforms as well as update (write) data as part of a two-phase commit across heterogeneous platforms.

The Sybase server software runs the data management and transaction functions. Sybase has one of the most fully-defined client/server architectures, whereby enabling data management and transaction functions are independently managed from the user interface and application functions.

An interesting feature of the Sybase architecture is the programmable server, which utilizes stored procedures and triggers to develop an intelligent database for programming organization-wide business rules and transactions on the server. This feature helps provide for centralized control over corporate-wide distributed data by allowing for changes in a database that is specific to a particular application, as data in a related database are changed, such as a new order triggering a change in an inventory database.

The leading categories of early adopters of the SYBASE SQL Server product, particularly on the OS/2 platform, have been VARs and integrators, who can maximise the benefits of lower-cost, multiuser database management systems (versus minicomputers), thus expanding their available market. They are also vendors that can provide the level of service support required for the SYBASE architecture.

The distributed database manager (data directory) standard or standards that evolve will be key to providing a true enterprise-wide distributed relational database architecture. The repository standards used for developing data-driven application development (CASE) solutions will also evolve as the standards for the distributed data directories. These directories could eventually provide a single logical view of the distributed data, which will be physically located across heterogeneous platforms. Thus, the adoption of particular vendors' application development tool architectures will play a major role in what computer systems emerge as dominant platforms in the client/server distributed relational database product environment.

2. Peer-to-Peer/Co-operative Processing

Industry definitions of peer-to-peer co-operative processing are even more varied than those for client/server co-operative processing. Theoretically, in a peer-to-peer implementation (as opposed to a client/server application architecture) the clients can communicate with other clients or servers without being dependent on routing though a particular server/ gateway (host) architecture. Application tasks are built on a modular basis and run on different computers but are all part of a single logical unit. The location of the various elements of the application are transparent to the end user. In essence, the network becomes the computer system.

This technology would be more of an ideal enterprise-wide distributed data processing environment, but it is not likely to be a realistic alternative for at least three to five years, due to the need to not only rewrite applications for single-vendor platform implementation but also to provide multivendor platform interoperability, which will require much more widespread support for communications and application programming standards. The further development of database management systems that are optimized for concurrent, multi-processing computer systems will also significantly enhance the efficiency of cross-network execution.

Enhancements of UNIX software for real-time, multiprocessing implementations with the execution of application modules in a parallel function across a network represent one prototype of a peer-to-peer processing implementation. DEC's VAXcluster product, with its loosely coupled multiprocessor, single-file structure architecture and multiuser read/write protection, represents another prototype.

Additional requirements will include the implementation of standards for the upper layers of the network protocol stacks, such as ISO/OSI; the use of cross-platform application development tools (such as portable 4GL tools or a third-generation language such as C); fibre optic networks; and, optimally, a common operating system environment with a scalable product architecture, along with the utilization of a standard data repository for creating distributed data directories.

4GLs such as Information Builders' FOCUS, which have been ported across multiple platforms from various vendors, represent examples of application development tools for distributing data under a single logical structure in a distributed, peer-to-peer architecture.

IBM has used the terminology of peer-to-peer processing in the context of implementing its program-to-program SAA protocols, LU6.2 and PU2.1, for communication among microcomputers, local-area networks, minicomputers, and mainframes with a common user access model that

can be built through support for its application programming interfaces and eventually with its AD/Cycle integrated application development tool product.

One of the more explicitly defined peer-to-peer (co-operative processing) application toolkits is Hewlett-Packard's Network Computing System (NCS) and Task Broker utility software. These toolkits facilitate development of distributed applications in a multivendor, co-operative computing environment. NCS, which has been licensed to other vendors such as IBM, DEC, and Microsoft, runs under MS-DOS, MVS, VM, VMS and UNIX operating systems. It is optimized more for new application development, where it allows programmers to design applications that can run on several networked computers simultaneously. NCS is also compatible with a number of protocol stacks, including OSI, SNA, MAP/TOP, and TCP/IP. NCS code, which is compiled into the applications, allows for the various subroutines of an individual program to be executed across platforms that support NCS. NCS is competing for the endorsement of the Open Software Foundation against Sun's NFS, which is part of Sun's Open Network Computing environment.

Task Broker software from Hewlett-Packard allows software developers to modify existing applications to run across a number of multivendor platforms in a network configuration to maximize distributed CPU capacity. It uses an intelligent bidding process to distribute entire tasks to the computer on the network that are best suited for each job. It enables software developers and end users to gain the benefits of distributing applications across a multivendor network without modifying existing applications. It requires no application modification. Task Broker is targeted for application development on UNIX platforms using TCP/IP protocols, such as HP and Apollo workstations. Future versions are being developed for DEC and Sun Microsystems workstations.

Task Broker is more a computer-system-to-computer-system communications tool in that it requires the complete application to be resident on the various platforms when it designates that a particular user can execute a program wherever CPU facilities (with the application resident) are available across a network.

Task Broker and NCS are key elements of a product strategy that HP is developing for building distributed applications for co-operative processing. The product elements also include administration applications for network-wide file system backup and user account registry and the adoption of the Open Software Foundation's Motif as a standard workstation and terminal graphics interface.

Hewlett-Packard has introduced the Team Computing program, a co-operative processing approach to multivendor computer configuration in a network environment, which utilizes the Task Broker and NCS tech-

nology. Team Computing is initially focused on project team needs in engineering or scientific and research programs and other project/team-oriented groups that share common work objectives and rely on computers and application programs from different vendors. HP describes the connectivity solutions as integrating a variety of individual systems into what is a distributed supercomputer. The program encompasses both existing and newly announced products. It is the first program to combine NCS with the X Window System and the Motif user interface.

The first Team Computing components include Task Broker, NCS, NCS-based system administration applications for all HP workstations, and a preconfigured X Windows environment to provide the same appearance and behaviour in HP and Apollo workstations and X Terminals by using the USF/Motif graphical user interface.

3. Co-operative Processing—Application Development Tools

To successfully compete (in the longer term) in the distributed database management arena by attracting support from application software developers, vendors of RDBMS-based server platforms need a comprehensive set of application programming interface software libraries, server-based programmable software utilities, and toolkits for developing front-end client/user interfaces. In addition, over the longer term, integration with a CASE repository standard will become increasingly important to encourage the larger, more-sophisticated software vendors to utilize a particular RDBMS for their integrated application development platform standard. The CASE repository will also play an important role in the evolving distributed data dictionaries required to provide administration of a distributed data environment.

IBM is providing such support with SAA programming interfaces and AD/Cycle and the MVS repository of developing SAA-based distributed applications.

DEC is providing such support with its Network Application Services program and its I-CASE environment based on its CDD/Plus repository. DEC's CASE product strategy, through supporting a number of industry standards in its I-CASE architectural building blocks, is targeting a multiple-platform development environment along with a distributed application development architecture. This strategy also includes support for a number of independent CASE tool vendors through its co-operative processing partnership program.

Oracle is also in the process of expanding its CASE product, which should complement its product offering in the client/ server distributed database market. An added advantage of Oracle is its broad-based hardware platform support with ORACLE RDBMS.

The dispute about standards among companies promoting various client/ server architectures relates to the lack of industry standards for the upper layers of the ISO/OSI protocol stack. A number of Remote Procedure Call de facto standards have been promulgated by various hardware and systems vendors, such as CL/1 from Network Innovations (an Apple Computer subsidiary); Sybase's C/SI Open Client and Open Server interfaces; NCS from HP/Apollo; Oracle's SQL*Net TM; and Sun Microsystems' ONC/NFS. For multivendor interoperability, remote procedure calls from a particular vendor must be implemented across servers from diverse vendors. DB/ACCESS has also jointly developed data linkage products with Cognos, Inc., which allows Cognos' PowerHouse 4GL users to access data on IBM mainframes from the minicomputer and microcomputer platforms supported by the PowerHouse 4GL. DB/ACCESS' generic access tool under development for the client/server environment could require embedding only on the platform initiating the remote procedure request.

B

Application Development Tool Technology

The anticipated shift in the software products markets in the 1990s— towards a concentrated focus on the end user, enterprise-wide information access, and integrated application interoperability—will significantly increase the complexity of the software development process. For development environments—for example, distributed/co-operative processing—this shift will also require major rewrites of current software products.

In addition, the increasing complexity of software development will also have a major impact on IS departments' ability to staff for the required breadth of skills required, such as professional services, systems integration, and network development and administration. As a result, the 1990s will likely reflect a continuing trend to more joint internal/ external product development projects. Internal application development still represents a very significant proportion of budget expenditures. The major shift in the apportionment of development expenditures is towards a combination of internal and external resources for product development.

A key factor for third parties penetrating the in-house software development environment is the need to be more cost-effective in developing a custom or customisable product than can be done internally, and to be able to provide a broad base of support services. This area is being addressed by commercial systems integrators, particularly in the larger Fortune 1000 companies. Therefore, independent software developers should increasingly look to alliances with systems integrators as a key method of approaching these markets.

In addition, independent software suppliers will be able to shorten their own software product development cycle and provide more easily

customizable products through the utilization of newer generation software development automation tools.

Leading trends in software application tool technology are highlighted in the following sections.

1. CASE

The definition of CASE is still evolving. The larger segments of the current CASE market, as defined by INPUT, are highlighted in Exhibit V-2.

Currently, CASE is considered a subsegment of the much larger applications development tool market, which INPUT estimates to total approximately $4 billion in 1990. The largest segment of the total applications development tool market is represented by database management systems software, which is estimated to total $2 billion in 1990.

For the long term, it is projected that the definition of CASE will eventually encompass the entire range of application development tools. In particular, they will be increasingly integrated within a central repository environment. Application code generation technology will expand to include a number of languages, in addition to COBOL, and high-end 4GL products will evolve into sophisticated front-end meta-languages for generating total systems program code. Unisys, for example, is reshaping Mapper and LINC II 4GL products within such a total CASE product delivery.

EXHIBIT V-2

84

CASE Industry Segments

- Front-end (upper CASE)

- I-CASE (upper and lower CASE)

  - I-CASE with integrated expert systems

  - I-CASE with reverse engineering

- Testing/debugging tools

- Application code generators

- Re-engineering

- Automated change management/project management/document generation

- Professional services/CASE integrated products

- DBMS and 4GL vendors: adding CASE to proprietary products

The PowerHouse 4GL product, a leading multivendor 4GL product for the minicomputer market from Cognos, has been linked to Index Technology's Excelerator front-end CASE tool, which provides for the translation of systems designed in Excelerator to PowerHouse 4GL code. Object-oriented data management software will play an increasing role as an integrator of various tools within an I-CASE environment.

INPUT's model for the industry structure of I-CASE in the mid- to late-1990s is given in Exhibit V-3.

Many re-engineering CASE tools can also address the broader programming environment, including analysis, coding, testing, documentation, and change management. One of the principal elements of many re-engineering products is a code navigator for converting COBOL spaghetti code into a more structured code format.

For the most part, the reverse engineering capabilities of most I-CASE vendors are currently in an emerging phase. CGI Systems, Texas Instruments, Bachman Information Systems, and KnowledgeWare offer some

tools for the emerging reverse-engineering models in the I-CASE environment.

Vendor announcements of longer term CASE strategies include IBM's AD/Cycle, with the related product support from third-party tool partners, and DEC's announcement of a number of new front-end tools to complement its CDD/Plus repository. The commercial success of CASE products from the computer systems vendors will likely be a key to the longer-term competitive success of hardware. For example, a major product goal for IBM's AD/Cycle CASE product appears to be to provide independent software developers with an integrated application development product for developing SAA-based solutions.

Endorsements of I-CASE products by large computer systems vendors such as IBM, DEC, and Unisys should lead to some major re-evaluations in the information services industry on the topic of software development automation. In addition, standards should emerge in the industry over the next few years, as these and other larger CASE vendors deliver on their I-CASE strategies. Hopefully, it will not lead to a prolonged period in which the larger CASE vendors seek to establish de facto standards, and co-existence with other vendors' tools is made more difficult. This would only prolong the existing state of confusion about CASE within the information services industry.

Current CASE product trends include:

- New-generation platforms based on co-operative processing architectures, principally the client/server model

- Single application tool vendors moving towards an I-CASE solution through a combination of internal development and strategic alliances—i.e., IBM's AD/Cycle partnerships, which include front-end analysis and design, re-engineering, and change and configuration management CASE tool vendors

- A growing emphasis on professional services due to the increasing recognition of the importance of education and training and other consulting services to successful CASE implementation

- Increasing interest in re-engineering technology for improving the productivity of existing programs and for migrating to other database architectures

- Development of strategic alliances in CASE around perceived de facto repository standards

- Increasing integration of the individual elements of the application development tool market into a total I-CASE solution in newer product releases

EXHIBIT V-3

Future I-CASE Industry Structure

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                    ┌──────────────────────────────────┐
                    │  Application Development Tools    │
                    │            (ADTs)                 │
                    └──────────────────────────────────┘

   ┌──────────┐   ┌──────────────┐   ┌──────────┐   ┌──────────┐
   │          │   │  Program     │   │          │   │  CASE    │
   │  DBMS    │   │  Development │   │ Languages│   │  Tools/  │
   │          │   │  Tools       │   │          │   │  Toolkits│
   │          │   │  (PDT)       │   │          │   │          │
   └──────────┘   └──────────────┘   └──────────┘   └──────────┘
```

- DBMS

- Data
  Dictionaries

- Application
  Generators

- Documentation
  Generators

- 4 GLs

- Assemblers/
  Compilers

- Methodology
  Companions

- Toolkits

```
          ┌──────────────────────┐
          │      Complete        │
          │      CASE            │
          │      Systems         │
          └──────────────────────┘
```

- Workbenches

- IPSEs
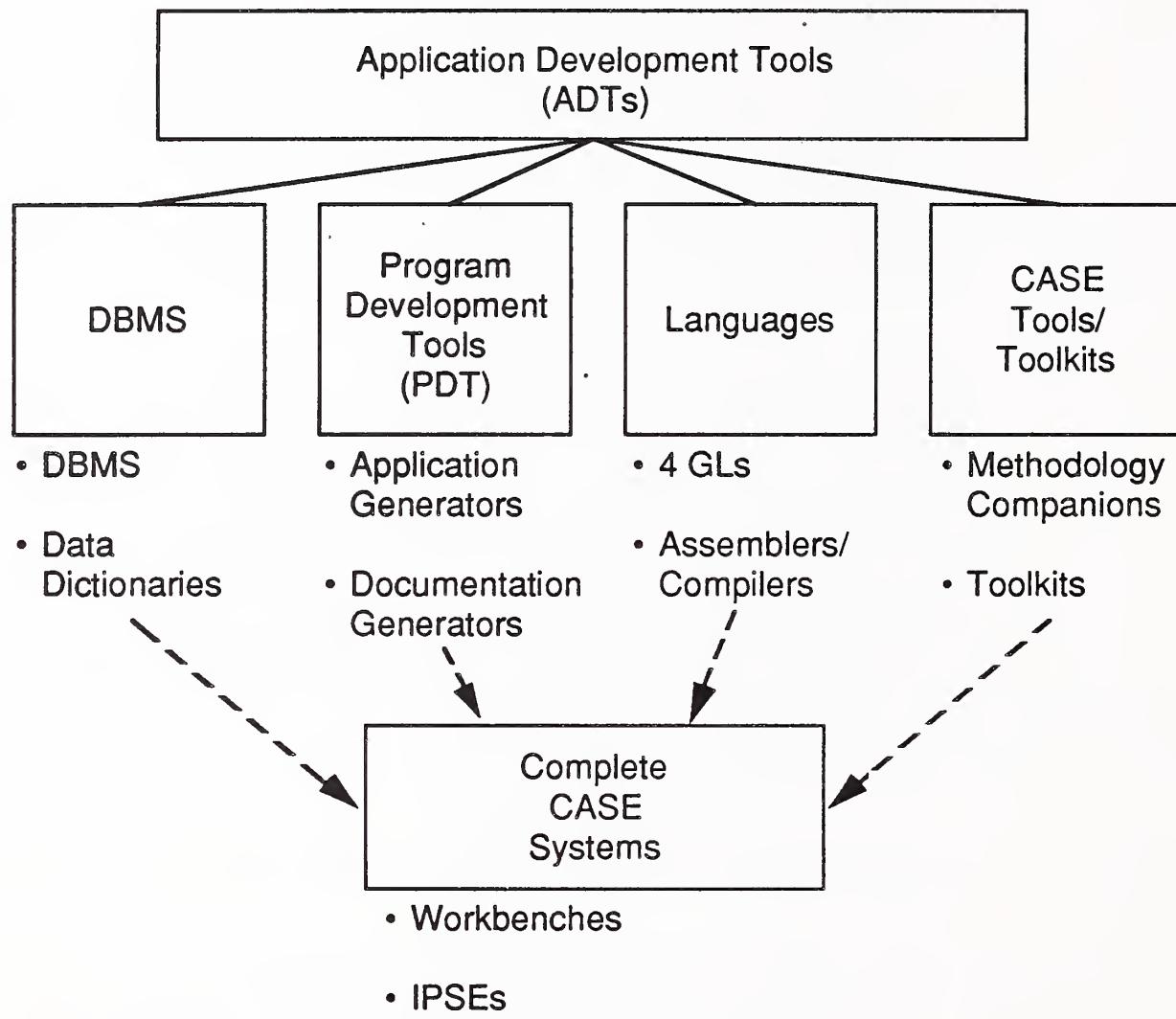
2. Object-Oriented Technologies

Object-oriented technologies and models are more often being utilized in applications that require the creation of linkage within complex data models—to enhance the efficiencies of programming through creating extensible/reusable code and through object-oriented data technology, thus helping to optimize the integration of multimedia applications, among other applications.

Over the past couple of years, leading independent companies in the object-oriented database technology market, such as Ontologic and Servio Logic, have introduced new product releases that improve the speed of object-oriented database access and can support more-traditional programming languages, such as C and its object-oriented extension, C++.

INGRES recently introduced the INGRES Intelligent Database product suite that includes extended data management facilities along with the ability to manage objects and to embed rules or knowledge directly into the database. The two products incorporated into the INGRES DBMS, which constitute the Intelligent Database, are INGRES Object Management and Knowledge Management. The Intelligent Database is based on the INGRES Release 6 Client/Multi-server Architecture. Knowledge Management includes features such as business rules, which can transparently track everything from referential integrity to changes in inventory and warehousing, to documentation and purchasing procedures. Object Management enables the database server to manage industry-specific or nonconventional data as well as to manipulate that data via a user-defined data facility.

IBM and Microsoft have indicated that they will add objects to OS/2, including voice, image, music and video, to help increase the efficiency and ease of design of application interfaces as well as the breadth of product development capability.

Information Builders has announced that a future release of its 4GL FOCUS product will include object-oriented technology extensions. The incorporation of object-oriented extensions to 4GLs should help facilitate future integration into I-CASE solutions.

Practical implementation of image processing/document management products is being built based on object-oriented database models (particularly for engineering document creation) by companies such as Intergraph.

The original object-oriented programming model was the one incorporated in the Apple Macintosh interface, and it has led to a number of program offshoots, such as HyperCard embodiments, that use object-oriented models. A principal benefit of the object-oriented application development technology embodied in the Apple Macintosh is the ability to encapsulate files and applications within the same command (icon interface). Hewlett-Packard has also done this with its NewWave application development technology.

Object-oriented technology is increasingly becoming part of CASE application development tool architectures. Oracle includes CASE tools in its SQL Forms product offering and IBM is utilizing object-oriented data directory management in its MVS/Repository product.

Some of the major drawbacks to the technology today include the lack of:

• Programmers trained in the technology

• Implementation of OODBMSs by the larger database management systems companies

- Sufficient application development tools for the technology

- Some performance trade-offs with other database management technology. C++ appears to be the evolving standard object-oriented programming language in terms of vendor support.

3. Knowledge-Based Systems

The strong growth in product licensing activity and revenue growth exhibited by third-generation knowledge-based/expert systems applications development tool vendors suggests that a healthy industry segment in this sector of the artificial intelligence market is emerging. Exhibit V-4 shows the stages of development of expert systems technology. The fourth state, commercial/industry packaged software, is still in a very early state of development. Companies such as Syntelligence have pioneered this market. Syntelligence, in the U.S., is marketing risk analysis application software, developed from Syntelligence's own expert systems application development tools, to the insurance and banking industries for issuing insurance policies or making loans.

EXHIBIT V-4

Stages in the History of Expert Systems
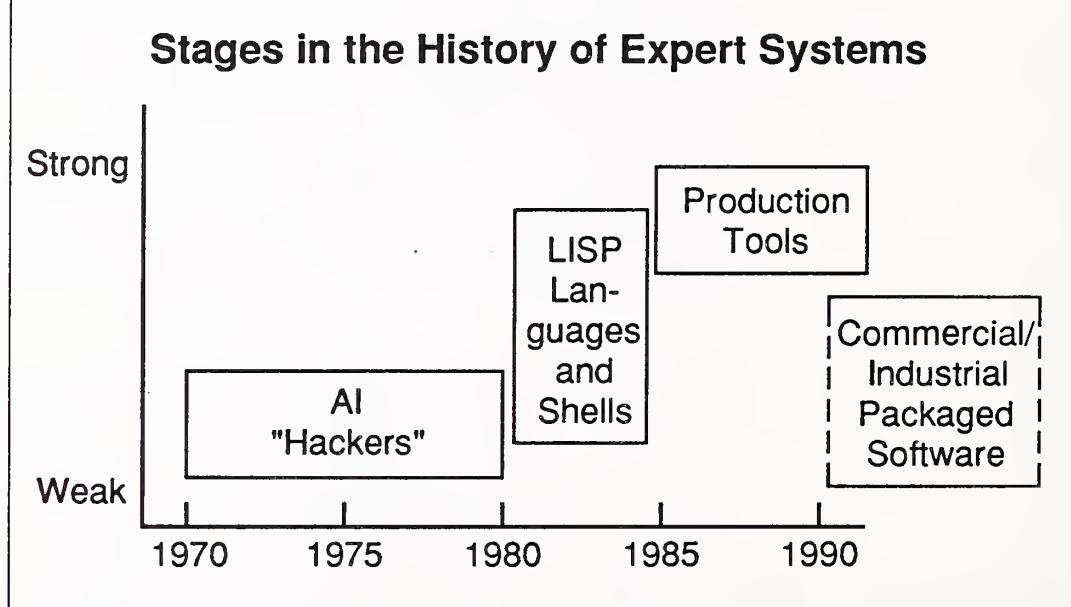
Approximately 80% of the product represents what might be called a generic solution and the other 20% is customized for the individual customer. However, a large market for expert systems standard application software is still several years in the future.

The real opportunity for software development is in embedding intelligence in new products to enhance competitive product advantages and to provide a strategic advantage in product manufacturing and/or delivery.

Newer generations of the products from these companies have been ported for application development across platforms ranging from PCs to

mainframes by utilizing the client/server development model. In addition, newer product releases from these companies provide enhanced capability to include programming hooks into complementary application development tools, such as 3GLs, relational database management systems, and object-oriented data management systems. Thus, expert systems/CASE tool capability is increasingly being integrated into broader systems development programs.

Expert systems development platforms, along with machine vision/robotics, represent the largest segments of the total artificial intelligence industry. The three other principal technologies—natural language, voice recognition, and neural networks (self-learning systems)—however, will likely represent the fastest-growing portions of the artificial intelligence market in the 1990s. Because of their ability to provide ad hoc inquiry in addition to programmed inquiry capability, natural language products like those from Natural Language in Berkeley, California, are finding increasing acceptance in the desktop environment for EIS and other types of decision-support systems.

C
Standards

1. "Look and Feel" Standards

Increasingly, computer systems vendors such as IBM, DEC, and HP are announcing plans to implement single computer systems/networking architectures as their future product direction. Nearly all are indicating longer-term support for the ISO.OSI model, with TCP/IP as the intermediary internetworking standard. However, there is considerable competition to establish de facto standards for the upper networking protocol layers—including the sessions, presentation, and applications layers—where the OSI standards are still in the process of definition.

UNIX is being supported by most larger computer systems vendors on some of their hardware platforms—including IBM's AIX, DEC's ULTRIX, and the HP-UX—as "the" alternative operating system, particularly for the scientific/government markets.

A list of some of the many information services standards that are in the process of development are included in Exhibit V-5.

CASE is one area where a number of de facto standards are emerging that are based, in part, on the developing nature of the product. Emerging CASE standards include the ANSI Data Dictionary Standards for CASE, which is IRDS; EDIF (an inter-face extension environment); the Portable Common Tool Environment; and CIS (CASE Integration Services Committee) for CASE standard interface, based on the Atherton Backplane Interface model, which is supported in the DEC CDD/Plus (Common Data Dictionary) repository. IBM is a member of CIS.

2. Database Interoperability

The SQL Access Group, composed of a number of hardware and software vendors, has announced its intent to develop a practical standard for database interoperability based on an open version of the SQL. This standard is designed to tackle the issue of the number of de facto standards for remote database access (RDA), which are being promoted by various leading DBMS vendors. In its model, the SQL Access Group is working to develop a standard version of SQL, a standard network protocol for remote procedure call (RPC), and a standard call-level application programming interface (API), which would allow software developers to write applications that could access multivendor databases.

An alternative is being offered by Sybase with its Open Server, a messaging solution that provides support for de facto standards or interoperability proposed for review by SQL Access. Sybase, however, is not a member of the SQL Access Group.

Other standards groups working along similar lines in trying to establish a standard among the various RDA protocols and SQL dialects include the International Standards Organization (ISO) and ANSI, which is also reviewing the ISO RDA standard. ANSI has established the ANSI SQL standard. Apparently the SQL Access Group will utilize the ANSI standards as the core of a standard solution, but will try to accelerate achievement of some type of industry consensus on such standards.

EXHIBIT V-5

Selected Standards in Progress

• Screen	Microsoft Windows; Presentation Manager; OSF/Motif; X/Open; News; NewWave; Nextstep; GEM; Display PostScript; Quarterdeck's Desqview; Open Desktop
• Graphics	TIFF; PICT; CGI; CGM; DMS; WKI; IGES; SGML; ODIF; DDIF (DEC)
• Communications	OSI; SNA; Ethernet; Token Ring; SONET; TCP/IP; MAP/TOPS; LU6.2; APPC; CL/I; NFS C/SI; SGLNet; FDDI; X.400; X.12; X.25; CITT.6 (Group 4); NCS; NetBios; LAN Manager; SMTL CMIS/CMIP SNMP; ISDN
• DBMSs	Codd's Rules; SQL; ANSI SQL; DB2
• Printers	Adobe's PostScript; DDL; Microsoft/Apple emerging standard
• Program Interfaces	IBM's SAA; DEC's enterprisewide architecture; POSIX
• Operating Systems	MS-DOS; OS/2; VM; MVS; UNIX; DEC VMS; PICK
• CASE	AD/Cycle; CDD/Plus; IRDS; EDIF; CIS

Appendixes
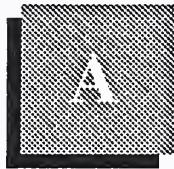
Definition of Terms

A

Overall Definitions and Analytical Framework

Information Services - Computer/telecommunications-related products and services that are oriented toward the development or use of information systems. Information services typically involve one or more of the following:

- Processing of specific applications using vendor-provided systems (called Processing Services)

- A combination of hardware, packaged software and associated support services which will meet a specific application processing need (called Turnkey Systems)

- Packaged software (called Software Products)

- People services that support users in developing and operating their own information systems (called Professional Services)

- Bundled combinations of products and services where the vendor assumes responsibility for the development of a custom solution to an information system problem (called Systems Integration)

- Services that provide operation and management of all or a significant part of a user's information systems functions under a long-term contract (called **Systems Operations**)

- Services associated with the delivery of information in electronic form—typically network-oriented services such as value-added networks, electronic mail and document interchange, on-line data bases, on-line news and data feeds, videotex, etc. (called **Network Services**)

In general, the market for information services does not involve providing equipment to users. The exception is where the equipment is bundled as part of an overall service offering such as a turnkey system, a systems operations contract, or a systems integration project.

The information services market also excludes pure data transport services (i.e., data or voice communications circuits). However, where information transport is associated with a network-based service (e.g., EDI or VAN services), or cannot be feasibly separated from other bundled services (e.g., some systems operations contracts), the transport costs are included as part of the services market.

The analytical framework of the **Information Services Industry** consists of the following interacting factors: overall and industry-specific business environment (trends, events and issues); technology environment; user information system requirements; size and structure of information services markets; vendors and their products, services and revenues; distribution channels, and competitive issues.

All **Information Services Market** forecasts are estimates of **User Expenditures** for information services. When questions arise about the proper place to count these expenditures, INPUT addresses them from the user's viewpoint: expenditures are categorized according to what users perceive they are buying.

By focusing on user expenditures, INPUT avoids two problems which are related to the distribution channels for various categories of services:

- Double counting, which can occur by estimating total vendor revenues when there is significant reselling within the industry (e.g., software sales to turnkey vendors for repackaging and resale to end users)

- Missed counting, which can occur when sales to end users go through indirect channels such as mail order retailers

Market Sectors or markets, are groupings or categories of the users who purchase information services. There are three types of user markets:

- *Vertical Industry* markets, such as Banking, Transportation, Utilities, etc.

- *Functional Application* markets, such as Human Resources, Accounting, etc. These are also called "Cross-Industry" markets.

- *Generic* markets, which are neither industry- nor application-specific, such as the market for systems software.

Specific market sectors used by INPUT are defined in Section D, below.

Captive Information Services User Expenditures are expenditures for products and services provided by a vendor that is part of the same parent corporation as the user. These expenditures are not included in INPUT forecasts.

Non-captive Information Services User Expenditures are expenditures that go to vendors which have a different parent corporation than the user. It is these expenditures which constitute the information services market.

Delivery Modes are defined as specific products and services that satisfy a given user need. While *Market Sectors* specify *who* the buyer is, *Delivery Modes* specify *what* the user is buying.

Of the eight delivery modes defined by INPUT, five are considered primary products or services:

- *Processing Services*
- *Network Services*
- *Professional Services*
- *Applications Software Products*
- *Systems Software Products*

The remaining three delivery modes represent combinations of these products and services, bundled together with equipment, management and/or other services:

- *Turnkey Systems*
- *Systems Operations*
- *Systems Integration*

Section B describes the delivery modes and their structure in more detail.

Outsourcing is defined as the contracting of information systems (IS) functions to outside vendors. Outsourcing should be viewed as the opposite of *insourcing*: anything that IS management has considered feasible to do internally (e.g., data centre operations, applications development and maintenance, network management, training, etc.) is a potential candidate for outsourcing.

IS has always bought systems software, as it is unfeasible for companies to develop it internally. However, all other delivery modes represent functions or products that IS management could choose to perform or develop in-house. Viewed this way, outsourcing is the result of a make-or-buy decision, and the outsourcing market covers any product or service where the vendor must compete against the client firm's own internal resources.

B

Software Products

There are many similarities between the applications and systems software delivery modes. Both involve user purchases of software packages for in-house computer systems. Included are both lease and purchase expenditures, as well as expenditures for work performed by the vendor to implement or maintain the package at the user's sites. Vendor-provided training or support in operation and use of the package, if bundled in the software pricing, is also included here.

Expenditures for work performed by organizations other than the package vendor are counted in the category of professional services. Fees for work related to education, consulting, and/or custom modification of software products are counted as professional services, provided such fees are charged separately from the price of the software product itself.

• **Systems Software Products**

Systems software products enable the computer/communications system to perform basic machine-oriented or user interface functions. These products include:

- *Systems Control Products* - Software programs that function during application program execution to manage computer system resources and control the execution of the application program. These products include operating systems, emulators, network control, library control, windowing, access control, and spoolers.

- *Operations Management Tools* - Software programs used by operations personnel to manage the computer system and/or network resources and personnel more effectively. Included are performance measurement, job accounting, computer operation scheduling, disk management utilities, and capacity management.

- *Applications Development Tools* - Software programs used to prepare applications for execution by assisting in designing, programming, testing, and related functions. Included are traditional programming languages, 4GLs, data dictionaries, data base management systems, report writers, project control systems, CASE systems and other development productivity aids. Also included are system utilities (e.g., sorts) which are directly invoked by an applications program.

• **Application Software Products**

- *Industry-Specific Application Software Products* - Software products that perform functions related to solving business or organizational needs unique to a specific vertical market and sold to that market only. Examples include demand deposit accounting, MRPII, medical record-keeping, automobile dealer parts inventory, etc.

- *Cross-Industry Application Software Products* - Software products that perform a specific function that is applicable to a wide range of industry sectors. Applications include payroll and human resource systems, accounting systems, word processing and graphics systems, spreadsheets, etc.

B
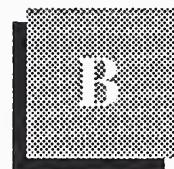
1990 Exchange Rates and Inflation Assumptions

EXHIBIT B-1

U.S. Dollar and ECU Exchange Rates, 1990

Country	Currency	U.S. Dollar Exchange Rate	ECU Exchange Rate
France	FF	6.17	6.87
Germany	DM	1.81	2.05
United Kingdom	£	0.631	0.74
Italy	Lira	1,336.0	1,502.0
Sweden	Sek	6.39	7.41
Denmark	DK	7.05	7.8
Norway	NK	6.85	7.94
Finland	FM	4.21	4.84
Netherlands	Dfl	2.05	2.3
Belgium	BF	38.06	42.29
Switzerland	SF	1.61	1.8
Austria	Sch	12.77	14.39
Spain	Ptas	115.8	129.7
Rest of Europe	$	1	0.83

EXHIBIT B-2

Inflation Assumptions

Country	Assumption 1989-1994	Assumption 1990-1995	Change
France	4	4.5	+0.5
Germany	2.5	4	+1.5
United Kingdom	5.5	7	+1.5
Italy	6	7	+1.0
Sweden	6	7	+1.0
Denmark	6	5	-1.0
Norway	4	5	+1.0
Finland	6	6	0.0
Netherlands	2	3	+1.0
Belgium	3.5	4	+0.5
Switzerland	2.5	5	+2.5
Austria	3	4	+1.0
Spain	5.5	6.5	+1.0
Rest of Europe	8	10	+2.0
European Average	4.5	5.5	+1.0
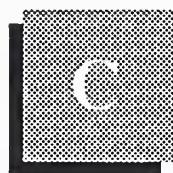
Detailed Forecast Data—Local Currencies

EXHIBIT C-1

	FF Millions								
Subsector	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	6,450	11	7,150	7,700	8,200	8,800	9,400	10,000	7
Minicomputer	3,700	20	4,450	5,200	6,100	7,000	8,100	9,300	16
Workstation and PC	2,000	28	2,550	3,150	4,000	5,100	6,500	8,200	26
Total	12,150	16	14,150	16,050	18,300	20,900	24,000	27,500	14

Systems Software Market Forecast in Local Currency by Market Segment, 1990-1995 France

EXHIBIT C-2

Systems Software Market Forecast in Local Currency by Market Segment, 1990-1995 Germany

Subsector	DM Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	2,000	9	2,170	2,400	2,600	2,900	3,250	3,600	11
Minicomputer	1,000	16	1,160	1,370	1,600	1,920	2,300	2,750	19
Workstation and PC	500	2,550	625	790	1,000	1,270	1,600	2,040	27
Total	3,500	13	3,955	4,560	5,200	6,090	7,150	8,390	16

EXHIBIT C-3

Systems Software Market Forecast in Local Currency by Market Segment, 1990-1995 United Kingdom

Subsector	£ Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	520	5	545	595	650	710	775	840	9
Minicomputer	280	13	315	370	435	515	610	720	18
Workstation and PC	160	2,550	190	240	315	400	515	640	27
Total	960	9	1,050	1,205	1,400	1,625	1,900	2,200	16

EXHIBIT C-4

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Italy

Subsector	Lira Billions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	850	7	910	980	1,060	1,150	1,240	1,350	8
Minicomputer	530	16	615	730	865	1,020	1,200	1,400	18
Workstation and PC	320	25	400	505	635	800	1,000	1,250	26
Total	1,700	13	1,925	2,215	2,560	2,970	3,440	4,000	16

EXHIBIT C-5

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Sweden

Subsector	SK Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	1,020	9	1,110	1,220	1,350	1,480	1,630	1,790	10
Minicomputer	425	16	495	585	685	795	925	1,080	17
Workstation and PC	255	27	325	410	510	645	815	1,030	26
Total	1,700	14	1,930	2,215	2,545	2,920	3,370	3,900	15

EXHIBIT C-6

Systems Software Market Forecast in Local Currency by Market Segment, 1990-1995 Denmark

Subsector	DK Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	650	8	700	750	805	860	920	990	7
Minicomputer	485	16	565	655	755	870	1,000	1,150	15
Workstation and PC	270	26	340	430	540	680	850	1,060	26
Total	1,405	14	1,605	1,835	2,100	2,410	2,770	3,200	15

EXHIBIT C-7

Systems Software Market Forecast in Local Currency by Market Segment, 1990-1995 Norway

Subsector	NK Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	595	7	635	690	750	815	875	940	8
Minicomputer	345	17	405	475	565	670	785	925	18
Workstation and PC	165	24	205	255	325	410	510	635	25
Total	1,105	13	1,245	1,420	1,640	1,895	2,170	2,500	15

EXHIBIT C-8

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Finland

Subsector	FM Millions							
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	355	7	380	405	440	475	500	530	7
Minicomputer	195	18	230	265	315	375	435	500	17
Workstation and PC	115	26	145	190	240	300	380	470	27
Total	665	14	755	860	995	1,150	1,315	1,500	15

EXHIBIT C-9

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Netherlands

Subsector	Dfl Millions							
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	550	7	590	635	690	745	805	860	8
Minicomputer	290	16	335	395	465	540	635	735	17
Workstation and PC	160	25	200	255	320	395	490	605	25
Total	1,000	13	1,125	1,285	1,475	1,680	1,930	2,200	14

EXHIBIT C-10

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Belgium

Subsector	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
				BF Millions					
Mainframe	5,900	7	6,310	6,750	7,250	7,850	8,420	9,050	7
Minicomputer	3,100	16	3,600	4,200	4,900	5,700	6,620	7,700	16
Workstation and PC	1,600	24	1,990	2,450	3,050	3,850	4,760	5,950	24
Total	10,600	12	11,900	13,400	15,200	17,400	19,800	22,700	14

EXHIBIT C-11

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Switzerland

Subsector	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
				SF Millions					
Mainframe	315	8	340	370	395	430	470	510	8
Minicomputer	150	17	175	205	240	280	330	390	17
Workstation and PC	75	27	95	125	145	185	230	290	25
Total	540	13	610	700	780	895	1,030	1,190	14

EXHIBIT C-12

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Austria

Subsector	Sch Millions							
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	1,220	7	1,300	1,390	1,490	1,590	1,690	1,800	7
Minicomputer	675	15	775	900	1,050	1,220	1,420	1,650	16
Workstation and PC	360	26	455	570	710	880	1,080	1,350	24
Total	2,255	12	2,530	2,860	3,250	3,690	4,190	4,800	14

EXHIBIT C-13

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Spain

Subsector	Pta Millions							
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	18,500	8	20,000	22,100	24,400	26,800	29,500	32,500	10
Minicomputer	10,200	19	12,150	14,600	17,500	21,000	25,200	30,200	20
Workstation and PC	5,300	27	6,750	8,600	11,000	14,100	18,100	23,100	28
Total	34,000	14	38,900	45,300	52,900	61,900	72,800	85,800	17

EXHIBIT C-14

Systems Software Market Forecast in
Local Currency by Market Segment, 1990-1995
Rest of Europe

Subsector	$ Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	60	8	65	70	75	80	85	90	7
Minicomputer	30	17	35	40	50	60	70	85	19
Workstation and PC	5	100	10	15	20	30	40	50	38
Total	95	16	110	125	145	165	195	225	15

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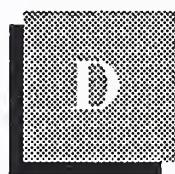
Detailed Forecast Data—ECUs

EXHIBIT D-1

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995 France

Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	939	11	1,041	1,121	1,194	1,281	1,368	1,456	7
Minicomputer	539	20	648	757	888	1,019	1,179	1,354	16
Workstation and PC	291	28	371	459	582	742	946	1,194	26
Total	1,769	16	2,060	2,336	2,664	3,042	3,493	4,003	14

EXHIBIT D-2

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995 Germany

Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	976	9	1,059	1,171	1,268	1,415	1,585	1,756	11
Minicomputer	488	16	566	668	780	937	1,122	1,341	19
Workstation and PC	244	2,550	305	385	488	620	780	995	27
Total	1,707	13	1,929	2,224	2,537	2,971	3,488	4,093	16

EXHIBIT D-3

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995 United Kingdom

Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	703	5	736	804	878	959	1,047	1,135	9
Minicomputer	378	13	426	500	588	696	824	973	18
Workstation and PC	216	2,550	257	324	426	541	696	865	27
Total	1,297	9	1,419	1,628	1,892	2,196	2,568	2,973	16

EXHIBIT D-4

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995
Italy

Subsector	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
			ECU Millions						
Mainframe	566	7	606	652	706	766	826	899	8
Minicomputer	353	16	409	486	576	679	799	932	18
Workstation and PC	213	25	266	336	423	533	666	832	26
Total	1,132	13	1,282	1,475	1,704	1,977	2,290	2,663	16

EXHIBIT D-5

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995
Sweden

Subsector	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
			ECU Millions						
Mainframe	138	9	150	165	182	200	220	242	10
Minicomputer	57	16	67	79	92	107	125	146	17
Workstation and PC	34	27	44	55	69	87	110	139	26
Total	229	14	260	299	343	394	455	526	15

EXHIBIT D-6

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995
Denmark

Subsector	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
			ECU Millions						
Mainframe	83	8	90	96	103	110	118	127	7
Minicomputer	62	16	72	84	97	112	128	147	15
Workstation and PC	35	26	44	55	69	87	109	136	26
Total	180	14	206	235	269	309	355	410	15

EXHIBIT D-7

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995
Norway

Subsector	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
			ECU Millions						
Mainframe	75	7	80	87	94	103	110	118	8
Minicomputer	43	17	51	60	71	84	99	116	18
Workstation and PC	21	24	26	32	41	52	64	80	25
Total	139	13	157	179	207	239	273	315	15

EXHIBIT D-8

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995 Finland

Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	73	7	79	84	91	98	103	110	7
Minicomputer	40	18	48	55	65	77	90	103	17
Workstation and PC	24	26	30	39	50	62	79	97	27
Total	137	14	156	178	206	238	272	310	15

EXHIBIT D-9

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995 Netherlands

Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	239	7	257	276	300	324	350	374	8
Minicomputer	126	16	146	172	202	235	276	320	17
Workstation and PC	70	25	87	111	139	172	213	263	25
Total	435	13	489	559	641	730	839	957	14

EXHIBIT D-10

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995 Belgium

Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	140	7	149	160	171	186	199	214	7
Minicomputer	73	16	85	99	116	135	157	182	16
Workstation and PC	38	24	47	58	72	91	113	141	24
Total	251	12	281	317	359	411	468	537	14

EXHIBIT D-11

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995 Switzerland

Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	175	8	189	206	219	239	261	283	8
Minicomputer	83	17	97	114	133	156	183	217	17
Workstation and PC	42	27	53	69	81	103	128	161	25
Total	300	13	339	389	433	497	572	661	14

EXHIBIT D-12

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995
Austria

Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	85	7	90	97	104	110	117	125	7
Minicomputer	47	15	54	63	73	85	99	115	16
Workstation and PC	25	26	32	40	49	61	75	94	24
Total	157	12	176	199	226	256	291	334	14

EXHIBIT D-13

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995
Spain

| Subsector	ECU Millions								
	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
Mainframe	143	8	154	170	188	207	227	251	10
Minicomputer	79	19	94	113	135	162	194	233	20
Workstation and PC	41	27	52	66	85	109	140	178	28
Total	262	14	300	349	408	477	561	662	17

EXHIBIT D-14

Systems Software Market Forecast in ECUs by Market Segment, 1990-1995 Rest of Europe

Subsector	1989	1989-1990 Growth (Percent)	1990	1991	1992	1993	1994	1995	1990-1995 CAGR (Percent)
			ECU Millions						
Mainframe	72	8	78	84	90	96	102	108	7
Minicomputer	36	17	42	48	60	72	84	102	19
Workstation and PC	6	100	12	18	24	36	48	60	38
Total	114	16	132	150	174	204	234	270	15
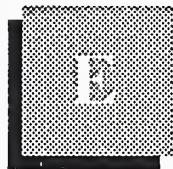
Forecast Reconciliation

Systems Software Products
Reconciliation of Market Forecast
Western Europe

1989 Market			1994 Market			1989-1994 CAGR Forecast in 1989 (Percent)	1990-1995 CAGR Forecast in 1990 (Percent)
1989 Report ($ Millions)	1990 Report ($ Millions)	Variance (Percent)	1989 Report ($ Millions)	1990 Report ($ Millions)	Variance (Percent)		
8,880	9,140	+3	19,680	18,350	-7	17	15

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